BOSTON UNIVERSITY

College of Business Administration

THESIS

Industrial Safety

by

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I. THE PROBLEM

A. Significance of the Problem

1. Significance to the Public.

The industrial accident problem is a very significant one from many points of view. This paper is concerned with and will limit its scope to the significance of the problem to the public, to the worker and to management. Let us first deal with the public interest that is involved in the maintenance of a safe working place. Society suffers because the costs of accidents like any other costs of production must be borne by the ultimate consumer as reflected in higher prices for goods and services. Taxes are higher; the people must support through taxation various governmental agencies that deal with the problem and help defray benefit costs. Private charities must be maintained by the private individual. Society has to carry and bear the burden of those workers who are permanently disabled and who are not fully effective producers. Last but not least, society suffers with the ensuing reduced income of the aggregate of injured workers. (1) The Old Testament recognized the social importance of safety when Moses in Deuteronomy admonished his people to have proper safety devices on the roofs of their houses so that persons walking by would not be

1. W. Dean Keefer, "Introduction to Safety Engineering," Industrial Safety, Roland P. Blake, Editor, Prentice-Hall, Inc., New York, 1946, p. 2.

injured. "When thou buildest a new house then thou shalt make a battlement for thy roof that thou bring not blood upon thine house if any man fall from thence." (1)

2. Significance to the Worker.

In the final analysis, the worker has the most at stake in an industrial accident; he is the one who suffers the most. No employer paid particular attention to his safety until Workmen's Compensation Laws were established, making it expensive for the employer not to protect his workers from on-the-job injuries. William Green, President of the American Federation, has summed it up rather well.

> To management the problem of industrial safety and hygiene is a problem of efficiency. Whatever interferes with the stability of working force is industrial waste - an expense that adds to production costs. The wage earner has more at stake in the industrial safety movement than any other group. His own physical and mental well-being is involved. The consequences to him are personal or irreparable. Naturally, therefore, the first protest against conspicuous industrial hazards came from wage earners, and our protests found effect in compensation legislation and constructive efforts to reduce preventable injuries. (2)

"Employees' losses greater than insurance payments and some classes are not insured at all." (3)

1. "Deuteronomy" XXII:8

2. William Green, "The Need for Safety from the Worker's Point of View," The Annals of The American Academy of Political and Social Science, Philadelphia, 1926, p. 5.

3. W. Dean Keefer, "Introduction to Safety Engineering," Industrial Safety, Roland P. Blake, Editor, Prentice-Hall, Inc., New York, 1946, p. 2.

"Although the employees' losses in actual money are not as great as the money losses of the employers when the concept of the marginal utility of the worker's dollar is employed and compared to the marginal utility of the employer's dollar we can see that the employee suffers most in lost utility." (1) More important, however, it is the worker who must bear the terrible pain and suffering and possible dismemberment that sometimes accompany accidents. According to National Safety Council Figures for 1940, we find compensation payments covering only one half wage loss. The worker's family suffers, also. For example, the mother might have to go to work, the children might have to cut their education short, and other plans that the family might have made might have to be scrapped because of the decreased or lost income from the family breadwinner. (2)

3. Significance to the Employer.

What is the significance of the safety to the employer? In the past he has had a disregard of the safety of his workers. Of course, there have been many exceptions and truly humanitarian motives have led many an employer to ensure his workers' safety and to take care of them when accidents did occur.... Early working conditions in America were deplorable following the Civil War which gave great impetus to industrialization of

1. W. Dean Keefer, "Accident Costs," Industrial Safety, Roland P. Blake, Editor, Prentice-Hall, Inc., New York, 1946, p. 28.

2. Ibid.

the United States. No attention was paid to the health, safety, and welfare of the worker. Light, ventilation, sanitation were not considered. Men worked from 12 to 14 hours per day. Death and injuries were frequent and were regarded as the price that society had to pay. As a group the employers felt no obligation to the worker for his safety. (1) Compensation was often made in form of a watchman's job for an injured worker or contribution to the funeral expenses for a dead one. (2) Experience has shown that no group can operate to the detriment of society as a whole or to a large segment of society without having to pay for their predatory acts in the form of government regulation. The clergy and press in Massachusetts, the leading industrial state at the time, advanced social and humanitarian arguments that led to the passage of safety laws beginning in 1867. (3) The various workingmen's compensation laws have made accidents directly costly to the employer and have contributed to his being more careful. (4) Also the costs of accidents exclusive of insurance premiums have been presented to the employer

1. W. Dean Keefer, "Brief History of Industrial Safety in America," Industrial Safety, Roland P. Blake, Editor, Prentice-Hall, Inc., New York, 1946, p. 12.

2. Ibid. p. 13.

3. Ibid. p. 13.

4. M. W. Alexander, "The Need of Safety from The Employer's Point of View," The Annals of The American Academy of Political and Social Science, Philadelphia, 1926, p. 7.

and he can see in black and white what safety means to him in dollars and cents - the language he can understand.

On the average each lost-time injury in industrial employment costs the employer approximately $950.00.

1940 U. S. Bureau of Labor Statistics

Deaths	18,100
Permanent Disabilities	80,600
Temporary Disabilities	1,782,000
	1,889,700 Total
Compensation Payments	$257,000,000
Medical Expense	$ 80,000,000
Overhead cost of insurance	$110,000,000

Compensation payments and medical expenses are referred to as "direct costs". All other expenses are referred to as indirect costs. Apply totals of direct costs to total injuries and we get $178.00 per injury. Careful analysis shows indirect cost four times direct cost. This brings figure to $890.00. The overhead cost of compensation borne by employers as a class adds another $58.00. The total, $948.00, is quite low as exempt labor would bring it up quite considerably. National Safety Council figures for 1941 are close to $948.00 per worker.

Wage loss (to injured workers)	$560,000,000
Medical Expense	90,000,000
Overhead cost of insurance	190,000,000
Total	$850,000,000

Of this, the direct cost, according to the Council, comes to about $425,000,000 because compensation payments provide for only a portion of wages lost by injured workers. Applying the 4/1 ratio the total cost becomes $2,125,000,000. Applied to the 2,180,200 injuries for 1941, we get $948.00 per injury. (1)

1. W. Dean Keefer, "Accident Costs," Industrial Safety, Roland P. Blake, Editor, Prentice-Hall, Inc., New York, 1946, pp. 22-23.

Indirect costs have been set down by H. W. Heinrich, Industrial Accident Prevention, McGraw-Hill, N. Y., 1941.

Indirect Cost

I Cost of lost time of injured employee.

II Cost of time lost by other employees who stop work.
- a. Out of curiosity
- b. To assist injured employee
- c. Out of sympathy
- d. For other reasons

III Cost of time lost by foreman, supervisors or other executives as follows:
- a. Assisting injured employee
- b. Investigating cause of accident
- c. Arranging for injured employee's production to be continued by some other worker
- d. Selecting, training or breaking in a new worker to replace the injured man
- e. Preparing state accident reports, or attending hearings before state officials.

IV Cost of time spent on case by first aid attendant and hospital staff, when not paid for by insurance carrier.

V Cost due to damage to machines, tools or other property, or to spoilage of materials.

VI Incidental cost due to interference with production, failure to fill orders on time, loss of bonuses, payments of forfeits and other similar causes.

VII Cost to employer under employee welfare and benefit systems.

VIII Cost to employer in continuing wages of injured worker in full after his return--even though the services of the worker (who is not yet fully recovered) may be for a time worth only one half their normal value.

IX Cost due to the loss of profit on injured workers' productivity and idle machines.

X Cost of subsequent injuries that occur in consequence of the excitement or weakened morale due to the original accident.

XI Overhead cost per injured worker--the expense of light, heat, rent and other such items which continue while the injured employer is a non producer. (1)

1. H. W. Heinrich, "Industrial Accident Prevention," McGraw Hill Book Co., Inc., New York, 1941, pp. 51-52.

This list does not cover all points that might well be considered. It does clearly outline the vicious and seemingly endless cycle of events that follow in the wake of accidents. The four to one ratios are a result of detailed on-the-job cost studies by experienced cost accountants. Good cases can be made for higher ratios due to distruction of expensive equipment. Five to one or six to one have been determined in studies. (1)

Here are a few examples of cost analysis under the Heinrich System:

Example 1. Foundry and Machine Shop. One year period. Lost time injuries 11, first aid cases 203. The accident cases were typical, the most serious being the spillage of a ladle full of molten iron due to cable breakage. This accident in which two men were burned, involved most of the compensation paid.

Compensation paid	$203.00
Medical expense	134.00
Total direct cost	$337.00
Lost time detail:	
Injured employees (lost time cases)	$ 34.68
Injured employees (first aid cases)	156.80
Fellow workman	102.00
Supervisory (judgment estimate)	80.00
Labor charge (clean up of ladle spill on overtime)	64.00
Production loss:	
Down time	92.50
Lessened production rate	65.00
Material spoilage	36.00
Machine and equipment damage	343.00
Overhead and administrative (records, executive time, other administrative) estimated at	350.00
Total indirect cost	$ 1,323.98
Ratio 3.91 (2)	

1. W. Dean Keefer, "Accident Costs," Industrial Safety, Roland P. Blake, Editor, Prentice-Hall, Inc., New York, 1946, p. 24.

2. Ibid. p. 25.

Example 2. Building Construction Job. Approximately 700,000 man hours. Lost time injuries 31, 19 additional cases sent to doctor, first aid treatments at job not reported on but estimate of cost included in the appraisal. The only serious mishap was the breakage of a guy cable causing the collapse of a derrick which fell across a truck and a shed filled with wall board. Truck driver's legs fractured and back injured.

Compensation paid	$323.00
Medical expenses	330.00
Total indirect cost	653.00
Unearned wages (time lost):	
Injured workmen	124.00
All others	314.00
To derrick collapse	
Derrick repairs	714.00
Truck repairs	627.00
Material spoilage	607.00
Labor clean up and rebuilding shed	345.00
Of the remaining accident occurences, 17 involved damage to equipment and material totaling	940.00
	$3,671.00

Ratio 5.6/1 (1)

Had there been any fatalities or permanent disabilities in the above examples the ratios would have been distorted out of the range of the ordinary ratios for an average of representative cases. In a large enough sample of representative industrial accidents where inevitably there would be some of the death or permanent disabling variety, they would not distort the ratio if included in proportions as found in the national injury toll.

United States Bureau of Labor Statistics
Figures for 1941

Fatal	881 or 0.88%
Permanent impairments .	4,615 or 4.6%
Temporary disabilities	94,500 or 94.5%
	100,000 or 100. %

1. W. Dean Keefer, "Accident Costs," Industrial Safety, Roland P. Blake, Editor, Prentice-Hall, Inc., New York, 1946, p. 26.

If, for instance, on this basis a reasonable allowance for fatalities and permanent disabilities were added to the direct cost in Example 1, the ratio would be changed only from 3.9 to 3.8 to 1.

It would have been entirely proper in the above examples to add an amount to the indirect cost to take into account the occasional accidents that involve heavy expense but not human injuries or losses. Unfortunately, there isn't sufficient data to arrive at the right allowance. Below is the type of accident to which I am referring.

> 1. Workmen, releving the rails on which an electric overhead crane ran, left a section of rail unsecure. When the crane wheels hit it, it yielded, wrecking the crane. The operator was providentially thrown clear and escaped with only bruises. Total cost, including rebuilding crane and department down time was over $100,000. (1)

The problem of industrial safety is one of national concern, indeed. The welfare of the people and of industry is involved. There is an enormous waste of material and human resources as well as the human values of life resulting from industrial accidents. Loss of life from industrial accidents in the history of the U. S. greater than the total losses from all the wars the nation has engaged in. (2)

1. Ibid. p. 27.

2. W. Dean Keefer, "Introduction to Safety Engineering," Industrial Safety, Roland P. Blake, Prentice-Hall, Inc., New York, 1946, p. 2.

B. WHAT HAS BEEN DONE IN THE FIELD

1. Earliest History.

Originally during the early days of the safety movement, safety work was just a job that was assigned to someone who could be spared from production work. Later some of the more idealistic of the technical or supervisory department saw the need and opportunity to serve and aid his fellow man. These were the pioneers of the safety movement. (1) There was not much need for safety in America prior to the industrial revolution in 1800 when steam engines were brought into Massachusetts to power the textile mills. The civil war and cotton gin were the great impetus to industrialization in America. (2) The working and safety conditions in these early plants were such that there arose a clamor for safety legislation to insure at least a minimum of safety for the worker. Massachusetts passed the first safety laws in 1867 and in 1869. These two laws provided for the services of safety inspectors, a bureau of labor statistics to study the problem, and to limit to 10 hours the working day for women. In 1877 Massachusetts passed laws compelling employers to safeguard hazardous machinery. In 1885 Alabama and in 1887

1. W. Dean Keefer, "Brief History of Industrial Safety in America," Industrial Safety, Roland P. Blake, Editor Prentice-Hall, Inc., New York, 1946, p. 12.

2. Ibid. p. 12.

Massachusetts passed Employers' liability laws. These laws were a step forward as they tended to make the employer responsible for accidents but they were pitifully inadequate as there were many loopholes: Contributory negligence, assumption of risk, negligence of fellow worker, and the necessity of the worker going to great expense to entertain litigation. As other states passed similar laws, insurance companies stepped in and inspected plants to set the premium rates according to the risk involved. At first they were purely evaluative; later they developed techniques for prevention. (1)

The Joliet Works of The Illinois Steel Company is often referred to as "the birthplace of the American industrial accident prevention movement." In 1892 a safety department was organized. The first order issued was for flywheel inspection. The move spread to other plants in the American industrial scene. (2)

2. Legislation.

The press and clergy kept hammering away for correction of the abuses of the present employers' liability laws. Organized labor was also struggling toward this same end. The Federal Congress passed the corrective legislation in 1908 but its benefits were meagre and limited to a special class of government employees. New Jersey led the states in

1. Ibid. p. 13.
2. Ibid. p. 14

this line by passing in 1911 the needed legislation. All the states but Mississippi have these laws now. The basic principle of these laws is that the employer is required to pay the injured worker's medical and hospital expenses and at least a minimum of subsistence for him and his dependents during his period of disability. There is no question of fault. The only requirement is that the worker must be injured on the job. Under proper administration, the worker can collect his benefits easily, quickly and with no expense nor litigation. These laws have done more, by making it directly expensive to the employer, to promote safety than all the other influences put together. (1)

3. Agencies.

Another milestone in our safety progress was the founding of the National Safety Council. In 1912, a group of engineers met in Milwaukee under the auspices of the Association of Iron and Steel Electrical Engineers to exchange ideas on cost, cause and prevention of accidents. These people were from industrial companies, insurance companies, federal and state governments and other interested groups. (2)

In 1913 a convention was held in New York City and the name was changed to the National Council for Industrial Safety whose attention was to be devoted to industrial safety only. In 1915, the name was changed once again to the National

1. Ibid. p. 14.

2. Ibid. p. 15.

Council for Industrial Safety whose attention was to be devoted to industrial safety only. In 1915, the name was changed once again to the National Safety Council whose purpose is to promote safety regardless of the origin of the accident. The organization publishes monthly magazines on safety as well as special semitechnical publications to promote safe practices. It also puts out rule books, posters and the like. The council maintains the most extensive safety library in existence and staff engineers gladly answer inquiries concerning all phases of accident prevention. Income is derived from member firms who pay a sliding scale of dues varying with the number of employees. Limited aid can be given non-members. (1)

Another thing that is being done to promote safety in this country is the organization of community safety councils. Pittsburg originated the first in 1917 with the first paid manager whose duty it was to get active support and cooperation of various civic, religious, educational and business groups in the city in promoting safety and carrying out of a comprehensive safety program. Safety meetings and conferences, rallies, contests, speaches and lectures, pamphlets and other forms of publicity are the means employed to achieve the community council's ends. These community councils originally founded to foster National Safety Councils ends locally have grown and there are over 60 and still signs of further growth. (2)

1. Ibid. p. 15.

2. Ibid. p. 16.

There are literally hundreds of other organizations that have been founded to promote safety in industry in specialized fields. (1)

There is the United States Bureau of Mines, Washington, D. C., which was organized in 1910 in the Department of the Interior to promote application of safety measures and study the causes of ill health and accidents among miners. It has done excellent work in connection with coal mine explosions. It gives first aid courses. It maintains coal mine inspection services for prevention of accidents and the dissemination of information. It works with appropriate state agencies. (2)

The Bureau of Labor Statistics, United States Department of Labor, Washington, D. C., was organized in 1913 to collect, tabulate and distribute statistical information about industrial accidents and industrial ill health. (3)

The National Bureau of Standards, Washington, D. C., was organized within the Department of The Interior in 1910 to create safety standards for various materials and equipment and to formulate testing methods for determining their safety. (4)

The Division of Labor Standards, United States Department of Labor, Washington, D. C., was created in 1934 to formulate labor standards in labor legislation and labor law administration and to promote improvement in working

1. Ibid. p. 16.
2. Ibid. p. 17.
3. Ibid. p. 17.
4. Ibid. p. 17.

conditions. (1)

In addition to federal bureaus or agencies, each state has its own department or bureau charged with safety of wage earners in the state. The Commonwealth of Massachusetts was first in 1867 with the Department of Factory Inspectors. These laws are aimed at correction of abuses and bad conditions, also in making it mandatory to guard hazardous machinery. There is a tendency toward the substitution of the sales approach for the use of the police power these days as a means of securing safety. (2)

The war gave great impetus to the safety movement in the United States with the ESMDT college level courses in industrial safety given by colleges and universities and administered by The United States Office of Education. Previous to the war, most safety training was in-plant training. Now, in the post war period, there is great promise for safety's being taught as a part of the regular curricula of many colleges and universities. A notable step in this direction has been made in some schools of engineering that are giving a course of study leading to the degree of Safety Fngineer. (3)

C. Approach

This paper will study the three sides of the industrial safety triangle: the psychological side will be studied

1. Ibid. p. 17.
2. Ibid. p. 18.
3. Ibid. p. 21.

under environmental and behavioristic aspects of safety, the educational side will be studied under the two chapters devoted to creating and maintaining an interest in safety from both the workers' and the executives' point of view, and the mechanical side will be briefly discussed under the topic of machine guarding. At the end will be a brief summary and conclusion.

II. PSYCHOLOGICAL BASES OF ACCIDENTS

A. Introduction

Many industrial psychologists claim that we have reached the point of diminishing returns in our industrial safety campaigns with the traditional methods of laws, standard practices, safety instruction, safety inspection and mechanical safeguards and what must follow,if further reductions of frequency and severity rates are to be obtained, is a detailed study into the human personality to discover what practical application to safety, psychology can make. (1) Moore has this to say on the importance of the human personality in industrial accidents: ". . . . . in many cases, the obvious cause has been only the immediate and easily observed factor, while the real cause has been in the form of remote experiences which project themselves into a situation not differing from that present throughout the entire working day." (2) The study of psychological techniques of accident prevention can be logically divided into two classifications -- the interaction of environmental conditions and personality and psychological traits and accidents.

B. Relationship Between Accident Frequency and Atmospheric Conditions

Numerous studies have shown a close relationship

1. Morris S. Viteles, "Industrial Psychology," W. W. Norton and Co., New York, 1932, pp. 332-3.

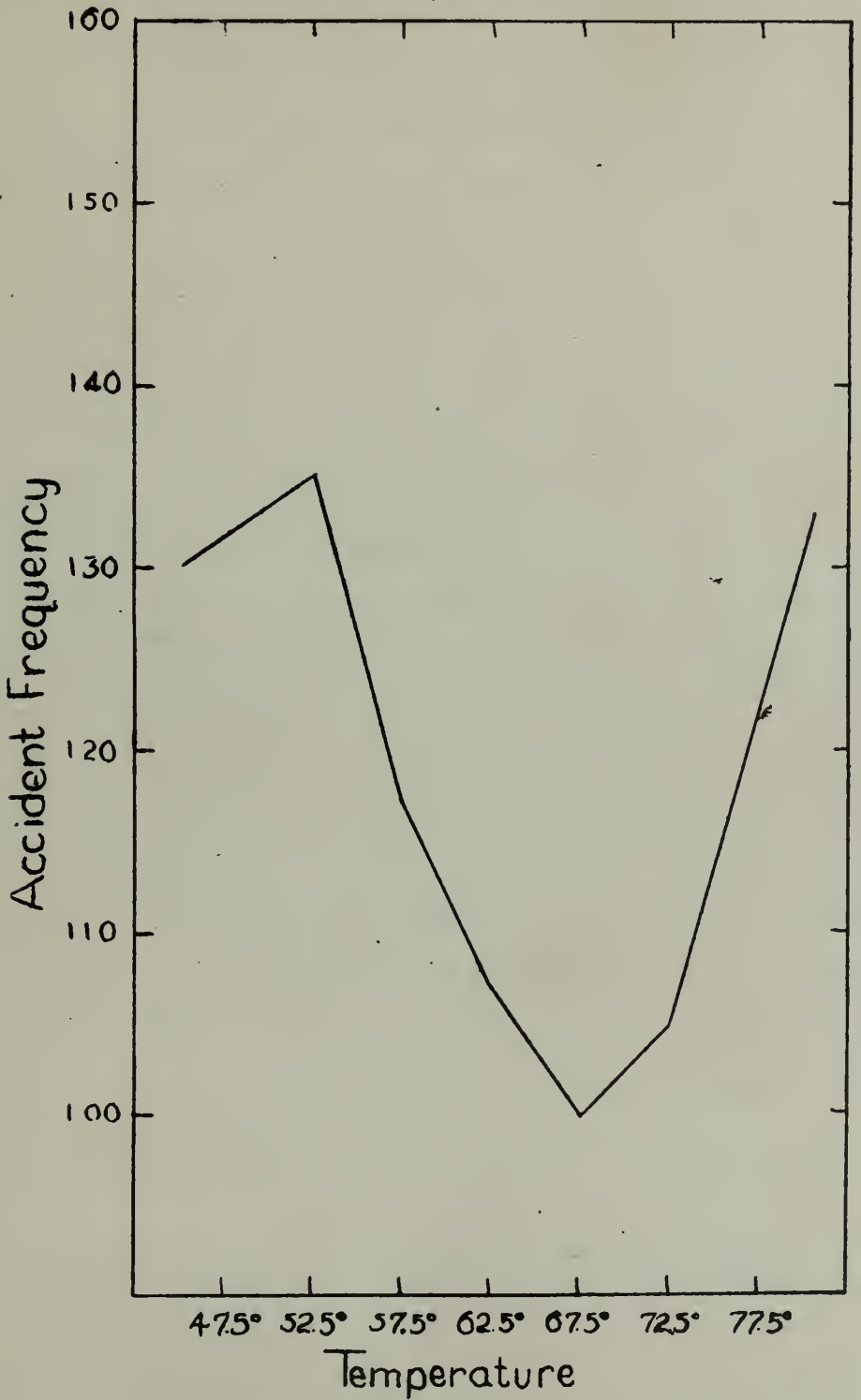
2. Herbert Moore, "Psychology for Business and Industry," McGraw Hill Book Co., Inc., New York, 1942, p. 334.

between accident frequency and atmospheric conditions. In general, these studies have tended to show that both the frequency and severity of accidents increase with changes in temperature. In one study, it was found that the average accident rate when the temperature was in the 70-74 degree Fahrenheit range was consistently lower regardless of the time of day than when in any other temperature range. In the same study, it was found that when the temperature was below 55 or above 75, a higher accident frequency rate was found than at any other time. It must be noted, however, that the effect of atmospheric conditions varies with the individual and, therefore, it is somewhat difficult to make generalizations concerning the optimum temperatures for a certain individual or for all individuals. For a majority of factory workers doing light factory work, it has been suggested from certain studies that a temperature of 64 degrees Fahrenheit is the most satisfactory. (1)

Temperature by itself, however, is not too satisfactory an indicant of comfort of an individual and the consequent liability of the individual to accident. The moisture content and the rate of air movement must be equated with temperature to get the best combination of all three for safety and comfort. Perhaps the best and most widely used measure of these three factors is the so called Effective Temperature. Effective temperature is defined as the temperature sensation set up in the human body by any combination of air temperature,

1. Ibid. p. 339.

Accident Frequency in Relation to Temperature



Source: Viteles Morris S., "Industrial Psychology", W.W. Norton and Co., New York.

humidity and motion. To illustrate: A person would be very uncomfortable in a room where the temperature was ninety degrees Fahrenheit and the humidity was very high. Reduction of the humidity, while keeping the temperature constant, would make for a much more comfortable individual. The introduction of a fan to circulate the air would make the same individual still more comfortable. Hence, identical temperature sensations caused by any combination of these three conditions are said to result from same effective temperature. Effective temperature is based on the temperature sensation produced by a given dry bulb temperature combined with saturated air. (1) For example, if the common thermometer indicates a temperature of 65 degrees and the air is saturated, the sensation produced is termed 65 degrees Fahrenheit effective. Of course, this same sensation can be felt with a higher temperature reading and less humidity. (2) Studies seem to indicate that an effective temperature ranging from 57 to 63 degrees Fahrenheit is the most satisfactory for comfort and for safety. (3) Much of this discussion of control of moisture content and rate of air movement is merely of academic interest to the personnel manager and the safety engineer: air conditioning equipment

1. Harold A. Alt, "Practical Air Conditioning," Domestic Engineering Co., Chicago, 1936, pp. 55-6.

2. Ibid. p. 56.

3. Herbert Moore, "Psychology for Business and Industry," McGraw Hill Book Co., Inc., New York, 1942, p. 339.

has not been provided in the shop (as it has in offices) except where the product requires it; the expense being prohibitive. The primary emphasis for the time being must remain with common ordinary temperature control in the absence of the means of control of the other two atmospheric conditions. (1)

C. Illumination and Accidents

1. Relationship

Studies have furthermore shown that there is a close correspondence between lighting conditions and accident frequency. In study in 1923, made by The Travellers Insurance Company, it was estimated that of the 91,000 accidents that were reported, 24% were due to imperfect lighting. There is conclusive evidence from many studies made on this subject, that other things being equal, there will be considerably less accidents in a properly illuminated shop than in an improperly illuminated one. (2) The problem of illumination is approached from two directions: Quantity of Illumination and Quality of Illumination. The Quantity of Illumination is measured in foot-candles. A foot-candle is the illumination produced by one standard candle at any point on a surface one foot away, and so placed that the rays from the light source meet the surface at right angles. (3) The British

1. Robert L. Morrow, "Time Study and Motion Economy," Ronald Press, New York, 1945, p. 150.

2. Herbert Moore, "Psychology for Business and Industry," McGraw Hill Book Co., Inc., New York, 1942, p. 346.

3. May Smith, "Handbook of Industrial Psychology," Philosophical Library, New York, 1944, p. 98.

Illuminating Engineering Society suggests the following foot-candles for factory work:

1. Precision work to a high degree of accuracy, tasks requiring rapid discrimination, displays. Above 50 foot-candles.
2. Severe and prolonged visual tasks, such as fine engraving, discrimination or inspection of fine details of low contrasts. 25-50 foot-candles.
3. Prolonged critical visual tasks such as drawing, fine assembling, fine machine work, proof reading, sewing on dark goods and typesetting. 15-25 foot-candles.
4. Visual tasks such as skilled bench work, sustained reading and sewing on light goods. 10-15 foot candles.
5. Less exacting visual tasks, such as casual reading and large assembly work. 6-10 foot-candles. (1)

The photometer is the instrument for measuring the quantity of illumination. It works by means of a photoelectric cell and a galvonometer. The current generated by the cell varies directly with the intensity of light and activates a calibrated galvonometer.

2. Quality of light.

The quality of light is dependent on three factors: diffusion, distribution and color value. The effects of quantity are lost because of unevenness, glare or faulty direction of light. Diffusion is the process of reflecting light by a reflecting surface or of the transmission of light through a translucent material. Diffusion if not proper causes light glare--"brightness of such a character as to cause annoyance, discomfort, interference with vision, and eye fatigue." Glare

1. Ibid. p. 58.

is of both the direct and indirect types. The problem of glare is one of the most acute in the field of illumination. (1) Direct glare comes directly from the source of the light to the eye. Its effect depends on the position of the light source in the field of view and on the contrast in the brightness between the light source and the background. The importance of the source of light varies accordingly as it is constantly or occasionally in the central portion of the visual field. If the source is in the central portion of the visual field for long periods of time, the brightness should be limited to one-half candle per square inch of illuminated area. If the source of light comes in to a person's field of vision only occasionally, the effects of glare may be eliminated by use of either indirect or semi-indirect lighting. Indirect lighting makes use of opaque bowls which reflect the light to the ceiling or walls which, in turn, reflect the light into the working area. Under the semi-indirect system, the bowls are translucent and some of the light filters down directly on the work. Indirect lighting is thought preferable by some to semi-indirect. Fluorescent lighting has many adherents as it gives well diffused light of sufficiently high intensity and at low operating cost. Reflected glare is glare that comes to the eyes as a reflection from the light source or from some polished surface. This is more insidious and more objectionable

1. Herbert Moore, "Psychology for Business and Industry," McGraw Hill Book Co., Inc., New York, 1942, pp. 350-1.

than direct glare. It often comes from a direction below the horizontal plane, a zone where the eye lacks natural protection. It is harmful because the eye is often subject to it for long periods of time unconsciously. Obviously, the logical cure is to locate the light source in such a position with respect to the work that the light will be reflected away from the eye instead of toward it. (1)

3. Distribution of Light.

There are two problems in connection with the proper distribution of light for adequate protection of the worker. The first is the problem of uniformity of illumination or the reception at all parts of the visual field of sufficient light intensity. Variations of light intensities have been studied and have been found to be rather large. In one study the variations were found to be as follows: 100 ft.-candles, 27 ft.-candles, 5 ft.-candles and 1 ft.-candle at various places within a large room. The procedure that is recommended to remedy these variations in intensities is space the light sources so that the distance between any two lights is not more than two and one-half times the height above the work plane and to supplement the general lighting system with specially shaded lights in places where work requiring close observation is being carried on. (2)

1. Ibid. pp. 350-1.
2. Ibid. pp. 351-2.

The second problem is the elimination of shadows. It must be stated here, however, that in some situations and for some types of work the presence of shadows is an aid; soft, well illumined shadows are helpful in distinguishing form and detail. On the other hand, are the kind of shadows that must be eliminated. Dark and black shadows make objects appear unpleasant and harsh, produce great contrasts in brightness and sometimes hide the moving parts of machinery. Elimination of undesirable shadows is achieved by proper spacing as recommended above. Indirect lighting is also felpful in this connection. To retain desirable shadows, it is effective to utilize semi-indirect lighting. The degree of shadow is controlled by varying the intensities of the translucent bowls used. (1)

4. Color.

The final aspect of lighting is color and its effects. In the first place, light should be of such a color quality that objects are seen in their true colors. This is especially true where the work requires the recognition by the worker of small differences in color. The way to achieve the proper color is to approximate the color of the northern sky in artificial illumination by means of blue glass bulbs or fluorescent lighting. (2)

The reflecting properties of the walls, ceilings and surroundings should be considered. If a person continually has

1. Ibid. p. 352.
2. Ibid. p. 353.

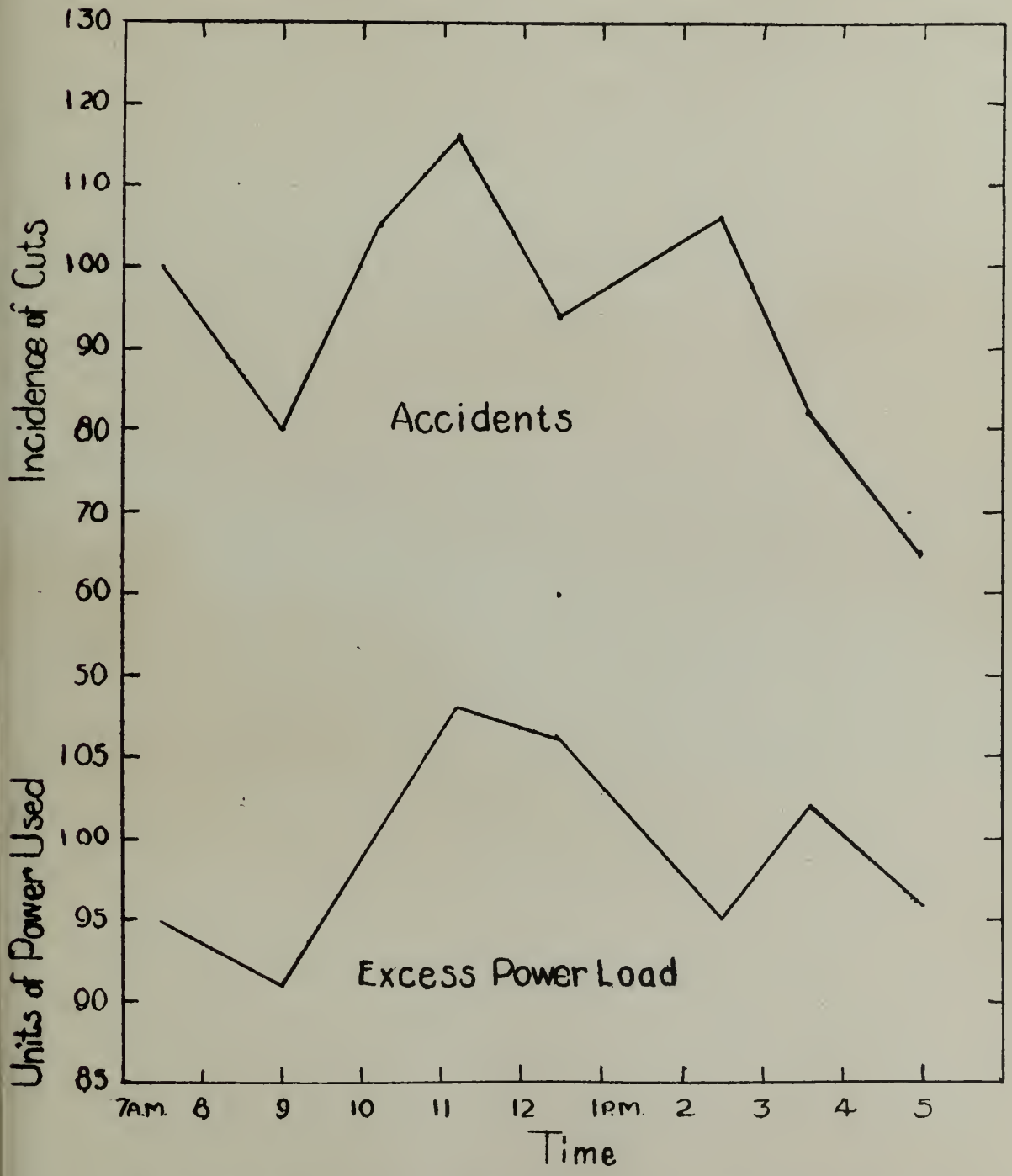
to face a large surface of wall finished in a light color and reflecting a high degree of light, the cumulative effect is an increase in fatigue, a decrease in production and an increase in accidents. Walls reflecting more than 50% of the light that strikes them are discomforting to the average worker. For a system of semi-indirect lighting or indirect lighting light ceilings and walls are the best. Generally speaking, walls that are finished in buff, light green or gray tints reflect the proper proportion of light. (1)

D. Pace and Accidents

What is the relationship between pace and accidents? The rate of accidents tends to vary directly with increases in production rates. In a study of accident rates and production rates in a fuse factory, it was shown that a twenty-five per cent increase in hourly output was accompanied by a 50 to 60 per cent increase in accident frequency. (2) This problem of pace and work is very complicated. Some industrial psychologists maintain that the relationship between speed and accuracy varies definitely with the character of the work, the workers themselves and the conditions under which the work is being done. The problem is quite complex, the variables involved are numerous and complex and the tests so far that have been made are incomplete and inconclusive and hence no

1. Ibid. p. 353.
2. Ibid. p. 355.

Accidents in Relation to Output



Source: Viteles, Morris S, "Industrial Psychology", W.W. Norton and Co, New York, 1932.

definite scientific conclusions can be reached concerning the optimum pace. To illustrate some of the variables that are involved, the experience in American Industry is helpful. The frequency and severity of accidents of American Industry have increased absolutely but not proportionately to the general increase in production from our factories. The proportion of accidents tends to decrease with increasing production. In 1925 the production rate quantitatively was 14.4% higher than in 1922, but the accident frequency rate was 10.4% lower and the severity rate was 2.5% higher in 1925 than in 1922. As Viteles says:

> This may suggest that increased rate or production favors accident reduction, but it is evident that increased production in industries studied is primarily associated with increased mechanization and not necessarily with an increase in the rate of work of those employed. In addition, the evidence indicates that the decrease in accidents in a given plant bears a direct relationship to the overall efficiency of the plant. A cutting edge that is kept clean not only cuts better and faster but it is less apt to cause accidents by breakage or by projecting particles of steel in the direction of the worker. (1)

The chart entitled "Accidents in Relation to Output" shows the relationship between accidents and pace found in one study made in a British munitions factory. Variations in power load as represented by the lower curve are equivalent to variations in output. This study indicated that variations in accident rate coincided with variations in

1. Morris S. Viteles, "Industrial Psychology," W. W. Norton and Co., New York, 1932, p. 362.

output as indicated by the power load curve. (1)

Undoubtedly, the question of the proper pace rests within the province of time and motion study. The pace for each job and for each operator could be experimentally determined by timing an average or better than average worker who has been trained in what has been found to be the best standard practice for doing a given job.

There are many other environmental conditions that contribute to a worker's liability to accident via their fatiguing effect on the worker and hence will be discussed under the general problem of industrial fatigue.

E. Fatigue

1. Relationship to Accidents.

The part that fatigue plays in accidents has been debated for quite some time by students in the field of industrial psychology. The most commonly accepted conclusion about the relationship of the rate of accidents to worker fatigue is that as the day progresses the effects of fatigue increase with consequent slowing down of the production rate and the upping of the accident rate. In a work day that is divided into two periods separated by the lunch period, the production rate starts high in the morning and continues that way for about the first hour or hour and one half after which it declines steadily to a low point just before lunch. The pattern

1. Ibid. p. 361.

is very similar in the afternoon on a somewhat reduced scale. The accident rate shows just the opposite picture as the production rate. The odd thing about this is that the accident rate for the morning is higher than the accident rate in the afternoon although the production rate in the afternoon is lower. This would seem to show that there is a lack of correspondence between the effects of the accumulated fatigue at the end of the day and the accident rates. The greater number of accidents have occurred in the morning where fatigue is less than in the afternoon. The problem of a decreasing number of accidents in spite of increasing fatigue was resolved by the United States Public Health Service in a 1920 study of 46,000 accidents in two metal manufacturing plants. The study showed that although the absolute number of accidents was less in the morning than in the afternoon, the number of accidents per unit of production was higher in the afternoon than in the morning. Industrial psychologists conclude that moderate fatigue is not a serious cause of accidents, but excessive fatigue due to prolonged hard work or other factors is one of the most important factors in accident causation. (1)

2. Causes of Fatigue.

There are numerous causes for fatigue of the worker, all of which may be classed under the headings of:

1. Herbert Moore, "Psychology for Business and Industry," McGraw Hill Book Co., Inc., New York, 1942, pp. 418-20.

1. Unsatisfactory emotional adjustment
2. Bodily deficiencies
3. Unsuitable surroundings (1)

The last is perhaps of the greater interest to the personnel manager, although the other two are of interest to personnel managers who are seeking person centered approaches to the problems of accidents and fatigue. Under the heading of environmental conditions, the problems of air conditions, illumination, and pace have been dealt with in connection with direct accident causation. Six other environmental factors that cause accidents through the creation of fatigue are of interest to the personnel manager in his quest for reduction of fatigue and accidents.

1. Physical demands of job
2. Nervous demands of the job
3. Noise of the work environment
4. Accident hazards of the job
5. Duration and time of work period
6. Monotony of the job

3. Physical Demands of Job.

The actual demands on the physical resources of the average American worker are not great in this modern age as they were a generation or so ago. Most practitioners will state that it is too expensive to use human power instead of machinery. Where physical effort is required, however, longer and more frequent rest periods are in order to reduce fatigue. Reasonable incentives are called for also where hard physical labor is involved.

1. Robert L. Morrow, "Time Study and Motion Economy," Ronald Press, New York, 1945, p. 142.

4. Nervous Demands of Job.

The nervous demands of the job are a strong cause of fatigue. Machinery not in working order, poor tools, poor quality materials and a domineering attitude on the part of the foreman have been suggested as important causes of employee fatigue. (1)

These and other similar nervous demands of the job should be brought to the attention of line management so that appropriate corrective action may be taken.

5. Noise of Work Environment.

The noise of the work environment is believed to be another fatigue producing factor, although there is evidence to show that in certain circumstances the worker becomes acclimated to noise and ceases to be fatigued by it further. Although the experiments that have been conducted so far have tended to show that in general noise brings about a decrease in production, it cannot be said for certain that the results of these experiments characterize all work situations. On top of this, it has been shown that meaningless noises that are of moderate intensity become accepted as part of the environment whereas noises that have a significance for the worker by being either unduly harsh or moderately rhythmical have a disturbing effect that cannot readily be overcome unless the worker can attune his work to the rhythm of the noise.

1. Ibid. p. 144.

The effects of noise on a person are highly subject to individual differences and, consequently, further generalizations are not too valid. (1)

6. An Unsafe Workplace.

An unsafe workplace is also a fatigue producing environment. A worker who must constantly be on guard lest he be killed or maimed in an unsafe shop will fatigue faster, tend to become less careful and be highly liable for an accident. Here we have two forces of accident causation -- mechanical and psychological acting jointly on the individual worker to bring disaster upon him. The chapter on machine guarding is relevant in this respect.

7. Time and Length of Work Period.

The time and length of the work period is not overly important in this present day and age. Social legislation and organized labor have reduced the number of working hours per week to a point where fatigue from this cause is not too common. The night shift still presents a problem, however. The difficulty rests in the inability or the difficulty of a worker making the proper psychological, physiological and physical adjustments so that he may carry out his work without undue fatigue or strain. (2)

1. Herbert Moore, "Psychology for Business and Industry," McGraw Hill Book Co., Inc., New York, 1942, pp. 420-22.

2. Paul Pigors and Charles A. Myers, "Personnel Administration," McGraw Hill Book Co., Inc., New York, 1947, p. 254.

8. Monotony of the Job.

The monotony of the work is an indicant of its fatiguing effect. Short cycle jobs with the rate of work paced partially or entirely by machines are the greatest causes of complaints of job monotony. Monotony is an extremely subjective thing and is hard to analyze. Sometimes interest lies in the variety of the work. Sometimes interest lies in the impelling desire to do a difficult task successfully. Sometimes the color or the texture of the material gives an emotional uplift from fatigue. Social contacts ease the monotony of the work. The emphasis of the importance of the job may be a means of securing interest. The place on the scale of occupational hierachy that the job occupies is very important. A job that carries prestige and high status is less fatiguing than a job of low status and prestige. Variations in the work procedure have been found to yield higher production and less fatigue. Personal and incidental pauses are also good for reducing fatigue and upping production. Doing an unproductive but necessary job such as changing a work ticket gives a worker a refreshing mental and physical change. The allowance of personal pauses to get a drink of water are very beneficial if not abused. Some plants have regular rest periods of ten to fifteen minutes once in the morning and once in the afternoon with the result of less personal time and increased production. Some plants play music to reduce monotony. The total playing time is usually found best to be about two and one-half hours in periods of ten to twelve

minutes. (1)

F. Accident Proneness

1. Introduction.

Research into the human mind and personality by the modern analytical techniques of psychology and psychiatry has given industrial society insight and knowledge of the causes and methods of prevention of industrial accidents. The inadequacy of mechanical safeguards and methods of conscious motivation as means of achieving an accident free record neccesitates a knowledge on the part of the safety man or personnel manager of the personal aspects of accident causation and prevention.

Estimates vary as to the relative importance of personal factors in accident causation. The thought of The National Safety Council is that personal causes account for 20% alone and 60% in reaction with the environment.

2. Distribution of Accidents.

The distribution of occurrences of accidents does not occur according to a bell shape curve. There is a considerable percentage of workers who have an accident free record while a small majority of workers account for the great majority of workers. These workers are termed accident prone.

1. Robert L. Morrow, "Time Study and Motion Economy," Ronald Press, New York, 1945, pp. 151-9.

3. Experience.

Lack of experience is one of the prime factors responsible for accident frequency. The facts seem to show that up to the age of forty or fifty, length of experience is inversely related to accident frequency but after that period accidents tend to increase with age. (1)

4. Emotional Stability.

Another factor is lack of emotional stability in an individual. Studies of the accident prone person suggests that he is more easily upset and more excitable than the ordinary person. The accident prone personality abounds in psychoneurotic symptoms. Some industrial psychologists believe that tests of emotional stability are excellent indicants of accident proneness. The accident prone worker is more easily upset than the average person by unusual situations such as changes in environmental situations, suddenly imposed tasks, increased efforts at speed, or unpleasant remarks from foremen or supervisors. These disturbances disturb the emotionally unstable person's capacity for making proper and sound judgments and proper muscular coordination. Psychologists believe that whenever a time-limited task is suddenly imposed upon an accident prone worker, there is a disturbance of his emotional balance and a consequent prevention of adequate sensori-motor

1. Herbert Moore, "Psychology for Business and Industry," McGraw Hill Book Co., Inc., New York, 1942, pp. 359-60.

response with consequent likelihood of accident. Below is a list of some of the causes of emotional instability:

1. Plant worries caused by poor personal relationships with fellow workers or superiors and/or fears of discharge, demotion, accident, etc.

2. Home difficulties caused by family and neighbor troubles of various sorts.

3. Fatigue and loss of sleep. This is a vicious circle. Fatigue and loss of sleep are caused by worry and worry is accentuated by fatigue and loss of sleep.

4. Periodic emotional disturbances which accompany 40% of accidents. (1)

The above list suggests that the clinical person centered approach must be used to detect and correct the factors that lead to emotional instability.

5. Physical Conditions.

A person's physical condition is an important factor in his proneness to accident. Surveys have shown that those situations which place unusual physical strain on the worker coupled with his lack of vigor and good health accentuate the worker's accident succeptibility. Surprisingly enough, even the more mild malaises can make a worker prone to accident. Toothaches, colds, sore throats and other mild ailments lead to danger of accident. Blood pressure is the most important single physiological factor in accident proneness. Studies have shown that groups of people with high blood pressure

1. Ibid. pp. 361-2.

have twice as many accidents per man as compared to "normal" groups. (1)

6. Use of Alcohol.

The use of alcohol has a profound effect on an individual's chances of having an accident. This does not apply to a person's drinking on the job as that is not at all a common practice today. In one study of the effects of off-the-job drinking, it was shown that chronic drinkers suffered nearly three times as many accidents as the group as a whole and lost more than three times as many days recovering from the accident. In another study it was shown that the number of accidents took a marked rise on Mondays and Saturdays. This attributed to a weekend habit of indulgence which began with the Friday afternoon pay. Alcohol increases the reaction time of an individual, stimulates his body functions, decreases his coordination and decreases his capacity for making accurate responses. (2)

7. Worker's Attitude.

Finally, there is the factor of the worker's attitude toward the organization. An accident prone worker is usually insubordinate, critical of supervision and inattentive to regulations. The cooperative attitude toward one's work is fully as important and necessary as the proper skills and motivating

1. Ibid. p. 362.
2. Ibid. p. 364.

forces. An indifferent attitude leads to boredom and decreased effort. An antagonistic attitude results in obstructionism. Absence of a favorable attitude towards one's job and its entire environmental setting expresses itself in ease of irritation, ready complaints and constant criticism, and, because of the ready distractibility of the individual, makes him highly susceptible to an accident when anything unusual happens in the work situation. (1)

8. Discovery.

What can the personnel manager do to discover the accident prone individual? Experience and experimentation have led to the conclusion that persons who have already had one or more accidents are more susceptible than is the person who has kept his accident record clear and that certain groups are predestined to have accidents unless preventive measures are taken either to remove the tendency or to remove the person from the danger area. There are four ways that are reasonably reliable in the detection of accident proneness.

9. Review of Record.

The employee's attendance record can help detect the probability that a person is accident prone. The accident prone person probably has a poor attendance record. There are so many valuable clues in a person's work experience record to aid in finding accident proneness. The personnel manager

1. Ibid. p. 366.

should watch for persons who are slower than the average, for those who make more mistakes than the average, for those who are not as amenable to discipline as other employees. These conditions should be cross checked with other factors in determining accident prone individuals. (1)

10. Intelligence Tests.

There is a great deal of disagreement about the validity of intelligence tests as related to accidents. No conclusive evidence has been presented to demonstrate a relationship between a low intelligence quotient and accident proneness. Low intelligence may be a contributory factor as it usually accompanies inaccurate observation and jusgment. (2) Intelligence that is too high for the requirements of the task is indirectly a cause of accidents as it induces boredom, fatigue and carelessness. There are more important personal factors in accident proneness than intelligence, however.

11. Tests of Coordination.

Tests of coordination of muscular movements and sense stimuli are very important in the detection of accident proneness. This type of test shows a more constant and frequent relationship to accident proneness than does any of the other types. The inability of an individual to perform satisfactorily on certain tests of sensori-motor reactions is

1. Ibid. p. 366.
2. Ibid. p. 367.

associated with his liability to sustain an undue number of accidents. Some of these tests are suggested below.

1. Dotting Tests
2. Pursuit Meter Tests
3. Tests for Reaction Time
4. Tests of Visual Perception
    a. Glare Blindness Tests
    b. Glare Recovery Tests
    c. Depth Perception Tests
    d. Peripheral Vision Tests
    e. Binocular Coordination Tests
    f. Tests for Ability to Estimate Speed
    g. Tests for Astigmatism and Color Vision

(1)

12. Tests of Emotional Stability.

Tests of Emotional Reaction and Stability are helpful in the determination of accident proneness. The resistance of the skin to the passage of electric current is decreased considerably when a person is in a highly emotional or excited state. To test the intensity of an emotion that a person experiences and the intensity of a person's reactions, a current is sent through a portion of a person's skin with a proper device for measuring the resistance in ohms that the skin offers to the passage of the current and the change in resistance is noted under various kinds of emotional situations. The tests have shown a high degree of correlation. (2)

In one study, the subjects who showed an above average frequency of resistance change had an accident frequency rate 67% higher than the persons having an average

1. Ibid. pp. 367-74.
2. Ibid. p. 375

frequency of resistance changes. Another study showed that those individuals that were tested and whose skin offered slow resistance to an electric current tended to have more than the average number of accidents. Another view of tests for emotional stability is that a test of sensori-motor coordination while a subject is subjected to intermittent emotional stimuli. This tests the ability of an individual to inhibit those muscular reactions that might interfere with the proper performance of a task when there is a disturbing or exciting situation present and result is an accident. (1)

13. Clinical Approach.

The best method of detecting accident proneness in an individual is through the clinical approach. Accidents are rarely the product of one deficiency in the psycho-somatic makeup of an individual. There are numerous factors that contribute to an individual's general inadequacy. The factors are called by various names by various psychologists and by the different schools of psychological thought but in general some of them are: age, experience, training, attitudes, physical condition, fatigability, perseverence or capacity for persistance, emotional balance and a host of others. An appreciation of the significance cannot be gained from any one index regardless of its validity in evaluating any one function. Accident producing behavior is a very complex psychological pattern. The pattern of the personality as a whole must be

1. Ibid. p. 375.

studied in order to gain an insight into the complex of inabilitied, distracting influences, experiences, motives and temporarily disturbing situations. The psychological clinical approach must be employed to get an understanding of the basic impulses that find expression in distorted ways, of environmental influences both at hand and operating within the field of ideas of the particular individual, and of the inferiorities that the individual tries to conceal or atone for by unusual behavior. This has been termed the person centered approach by some writers in the field of Personnel Management. (1)

1. Paul Pigors and Charles A. Myers, "Personnel Administration," McGraw Hill Book Co., Inc., New York, 1947, Chapter 4.

III. SELLING SAFETY TO THE WORKER

A. Introduction

The creation and maintenance of an interest in safety in the working force and the supervisory force is very fundamental if a good safety record is to be achieved.

The management that is not vitally and wholeheartedly behind safety will often allow unsafe conditions and unsafe practices to infiltrate and accumulate much to the detriment of industrial efficiency and industrial relations. The worker who is not sold on safety will not avail himself of the protective devices and rules that have been laid down for his well being. The worker who doesn't appreciate the importance of safety devices will tend to avoid their use. Mr. Charles Dyson, Safety Director at the Ford Motor Company's Somerville, Massachusetts, assembly plant maintains that unless the worker can see the personal and practical benefits that accrue from the use of safety devices and from the following of safe practices, devices and rules will be worthless. Fines, layoffs, discharges and other forms of discipline for safety rule infractions tend to result in the worker's being safety minded only when watched. Dyson feels that a feeling of mutual respect and good will between the safety department and the worker as well as psychological rapport is necessary to get the message across. It was formerly the practice at Ford to use plant guards to enforce safety rules. The methods

were somewhat "Gestapo"-like and the guards were resented by the workers. A worker spotting a guard might quickly put on his goggles while swearing under his breath at the hated safety man. Those who were unfortunate enough to be caught off guard were warned or disciplined depending upon the number of previous offenses charged against them. Needless to say the results were far from satisfactory and the Ford management has changed its ways. Over at Somerville, Dyson makes an inspection tour of the plant two or three times per day and in a jovial and friendly manner and in the language that the men can understand, he points out why a certain practice that an individual may have been following is detrimental to his health. The results have been encouraging, fewer accidents have resulted and the frequency and severity rates have noticeably improved. Dyson feels that Ford has a long way to go and a program of employeeeducation and participation is still in the formative stage.

B. Sales Appeals

The idea involved in getting safe practices across to the employees is to sell them on safety much the same as any salesman sells any commodity - certain psychological characteristics are appealed to. Roland P. Blake, Senior Safety Engineer, Division of Labor Standards, U. S. Department of Labor, lists the following as the characteristics, traits, desires or incentives in man that can be effectively appealed

to in the promotion of an interest in safety.

1. Instinct of self-preservation
2. Desire for material gain
3. Desire for praise, approbation or distinction
4. Fear of ridicule or disapproval
5. Sense of humanity
6. Sense of responsibility
7. Sense of loyalty
8. Competitive instinct
9. Desire for power and leadership. (1)

1. Self-preservation.

The instinct of self-preservation is thought by some to be the strongest of the so-called instincts. It is appealed to by showing the possible danger to life and limb that can result from unsafe acts and practices. Dyson of Ford, for example, was formerly in the service and maintenance department and bears a scar that resulted from the use of a "mushroom"-headed punch. When he comes across this type of unsafe practice, he shows the offending worker what might happen to him from the use of a similarly damaged tool. Sometimes a less serious accident can be beneficial by making a worker more careful in the future. For example, over at Ford, a worker dropped an automobile bumper on his foot; the next day this worker was seen wearing safety shoes, a practice he had avoided in the past. Dyson makes use of worker's mistakes such as this to instruct others. Very often, photographs of a bad accident have a good effect on a worker's attitude toward safety.

1. Roland P. Blake, "Methods of Promoting Safe Practice," Industrial Safety, Roland P. Blake, Editor, Prentice-Hall, Inc., New York, 1946, p. 240.

2. Desire for Material Gain.

The desire for gain and reward can be appealed to rather readily. Monetary and non-monetary rewards can be offered for safety performance and safety suggestions. The reward should be large enough to incite interest and should bear a reasonable relationship to the effort involved. It should be absolutely equitable and fair as any suggestion of favoritism will nullify its value. (1) Lever Brothers pays a small cash bonus for safety suggestions with the amount varying with the importance of the suggestion. Roland P. Blake suggests that a small award of a dollar or two per month be paid for every month that a worker works without a lost time injury. There are limitations to rewards as there are to all attempts at conscious motivation. Many accidents are caused by certain malfunctions in the psycho-somatic makeup of an individual. The person centered approach must be employed here. Another limitation is found where the awards go to individuals who would produce the desired conduct whether rewarded or not. A possible solution to this problem is to give awards on the basis of the greatest amount of improvement over a period of time as well as on the basis of the best record.

3. Desire for Praise and Appreciation.

The desire for praise, approbation, distinction can be appealed to by a variety of ways and means. Badges, honor

1. Ibid. p. 241.

dinners, public mention and personal letters from important company officials are some of the ways that this human trait can be appealed to. (1)

4. Fear of Ridicule or Disapproval.

The fear of ridicule or disapproval is rather strong in the human personality. In appealing to this human trait, care must be exercised lest emotional and defiant behavior be the result. Properly used, with the knowledge that a person is peculiarly sensitive to disapproval from those whom he likes, this personality characteristic can be a lever to secure good safety performance. For example, an employee violating a rule of safe practice in a unit that is competing for a certain safe practice goal, and especially where the unit has a good chance of attaining that goal, is very likely to have his bad safety practices corrected by his fellow employees in that unit. This is, indeed, a very effective way of securing good practice. (2)

5. Sense of Humanity.

The sense of humanity can be appealed to also in promoting safe practices among employees. Very often in a matter of fact way the safety director can bring this out. Rarely can a man be found who, when shown that his unsafe conduct might lead to danger for his fellow workers, will not

1. Ibid. p. 241.
2. Ibid. p. 241.

correct his behavior. (1)

6. Sense of Responsibility.

Closely allied to this is the sense of responsibility that inheres in most individuals. Few people knowing that others are dependent on them for performance of work in a specified manner will shirk their responsibility. This trait can be combined with the desire for praise by giving a person a generour, but reasonable, reward for responsibilities that are correctly and efficiently carried out. (2) For example, you could assign a compressed air tool worker the responsibility of keeping the floor clean of oil near the high pressure air lines in order to avoid fire or explosion resulting from compressed air and oil.

7. Sense of Loyalty.

The sense of loyalty that men have to certain individuals, organizations, ideals etc. is another personality characteristic that may be appealed to rather advantageously. The appeals should bear a direct relationship to the realities of the situation or else they are a waste of time to all concerned. During the war, the plea was to loyalty and patriotism toward the nation. In peace, the plea must be for loyalty to the company, the leaders and to the fellow workers. (3)

1. Ibid. p. 242.
2. Ibid. p. 242.
3. Ibid. p. 242.

8. Competitive Instinct.

The appeal to the competitive instinct is rather good. Safety contests rest on this personality characteristic. The rules of the game must be clear, the contest must be a reasonable one, and the issue must be fairly decided for the contest to be an effective appeal to the competitive instinct. Cheating in contests in the past has created widespread criticism of this device. (1)

When correctly used, however, contests have served to pep up a lagging interest in safety and to defeat indifference, although the intermittent campaign is not as important as long term efforts to secure safety. (2)

9. Desire for Power and Leadership.

There is a desire for power and leadership to be found within the nature of man. Here, many devices are utilized. (3) Making safety performance a very heavy factor in promotion, is an effective way of appealing to this trait. Appointment to safety committees or offices in safety organizations are other ways of appealing to this trait. Some plants make men "safety monitors" if their record is good. These men are often given badges and told to aid in the detection and correction of unsafe practices among their fellow workers by means of moral suasion. The giving of special privileges

1. Ibid. pp. 242-3.
2. H. W. Heinrich, "Industrial Accident Prevention," McGraw Hill Book Co., Inc., New York, 1941, p. 87.
3. Ibid. p. 90.

above those given to ordinary workers is an excellent way of appealing to this trait.

10. Limitations of Appeals.

It must be noted that no one appeal can be used successfully with each individual. The above psychological characteristics that have been mentioned are stronger motivating forces in some individuals than they are in others. This is a case for the packaged approach; several of these traits must be appealed to in combinations varying with the nature of the particular individual which must be determined by astute personal observation and investigation. (1)

C. Sales Essentials

1. Utility.

In appealing to the above mentioned personality characteristics it is necessary that the safety man make use of techniques that are employed by salesmen in the marketing of goods and other services. It is perhaps appropriate at this time to review briefly the essence of the art and science of salesmanship. In the first, a good product is essential. A product that is going to have utility to the person to whom it is to be sold. Safety is a good product and it brings utility to the worker in the form of freedom from pain and suffering and to the employer in the form of reduced costs and increased production among its many benefits. No exaggerated

1. Roland P. Blake, "Methods of Promoting Safe Practice," Industrial Safety, Roland P. Blake, Editor, Prentice-Hall, Inc., New York, 1946, p. 240.

claims are necessary for the sale of safety - the truth will suffice. (1)

2. Knowledge of Product.

The next essential is that the salesman know his product. Constant study and research is a must if the safety man is going to command the respect of his "customers". (2) The safety man must be able to present workable safety rules and their reasons in order for the worker to put their faith in them. Dyson of Ford believes that it takes years of experience on the production line and a good knowledge of the techniques and of people to make for an effective safety man.

3. Sales to Fit Individual Personality.

The third essential is that the salesman key his sales effort to the individual personality. The good safety man is somewhat of a practical psychologist who seeks to learn all he can about the prospect and adjusts his approach according to the latter's personality. (3)

D. Steps in A Sale.

1. Preparation.

There are three basic steps in a sale -- the preparation, the presentation and the close.

The preparation involves getting together helpful

1. Ibid. p. 236.
2. Ibid. p. 236.
3. Ibid. p. 236.

information about the prospect and matching this information against the service of the product thus discovering what needs and desires of the customer the salesman should appeal to in order to sell the product. (1)

For example, in the course of trying to promote the use of safety shoes to protect a worker's foot from accidental injury, this preparation could be used. Through conversations with a particular worker or his friend or possibly through his employment application blank, the safety man might ascertain that this particular individual is a winter sports enthusiast -- skating and skiing in particular. The interest in skating and skiing might be easily matched with the foot protection function of the safety shoe.

2. Presentation.

The presentation involves the actual appeal to this interest by the "salesman--safety man". The safety man might gather pictures of foot injuries that might have been prevented had safety shoes been worn. These pictures, tied in to an informal conversation about skating and skiing, are very likely to have a beneficial effect. (2)

3. Close.

The close is the final step. The close involves correct timing. It takes experience and a developed judgment

1. Ibid. p. 237.

2. Ibid. p. 237.

to know when the customer is sold. The salesman gets his timing orientation from many verbal and non-verbal clues. Non-verbal clues are usually sub liminal and require experience and jusgment to detect and decode them. Verbal clues are very obvious often-times. "I guess you are right, I shouldn't ride the lift truck." "I didn't realize how necessary safety shoes were until you showed me that photograph of a crushed foot." Any sign that the worker is convinced is the cue to get the worker to "sign on the dotted line". When the commitment is made, selling should cease, and some form of commendation should be offered. (1)

E. Advertising Media

1. Posters.

Within the sales campaign for safety, as in other campaigns, there must be advertising. The media used are much the same as used for communications to the workers from management. Posters, bulletin boards, house organs, messages in pay envelopes, manuals and films are some of the more common. Posters are perhaps the most important means of getting the safety message to the workers. The picture is an excellent way to instruct: the eye is the quickest and easiest route for an idea to travel to the brain. Picturization, however, is limited to simple ideas and impressions and therefore is to be used with other means in the safety advertising campaign. Posters should be kept up to date and the message should be

1. Ibid. p. 237.

in keeping with current events and trends of thought. The poster should be designed so that the attention of those to whom the message is to be directed is caught, their thought processes should be stimulated and action by them should result. (1) The National Safety Council sends safety posters in unending variety to its subscribers. Insurance companies are another source. Many companies utilize hidden employee talent, uncovering it by means of poster contests. (2) Herbert Moore, Personnel Consultant, Stevenson & Kellog, Ltd., Toronto and Montreal, suggest the following rules in regards to posters:

a. They should represent actual occurrences in the plant and show how a particular type of accident has been caused.
b. There should be very little reading matter, and it should be clear enough to attract attention, even at a casual glance.
c. They should be placed in conspicious places, such as entrances, exits and selected working places, and should be changed at least every three weeks.
d. They can be effectively used if there is in them a touch of humor, provided they do not treat the accident situation with undue levity or vulgarity. (3)

2. Bulletin Boards.

The bulletin board is the device that is used in conjunction with posters and other safety messages to get

1. Ibid. p. 243.
2. W. H. Taylor,"Visual Education,", Transactions of 31st National Safety Congress, National Safety Council, Chicago, 1942, p. 691.
3. Herbert Moore, "Psychology for Business and Industry," McGraw Hill Book Co., Inc., New York, 1942, p. 381.

interest in and information about safety to the working force. The main purpose of the bulletin board is to create interest and to incite action. (1) It is with this purpose in mind that personnel or safety department should design and operate its bulletin boards. The location of the bulletin boards is a most important consideration. They should be located near but not in the centers of communication so that they may be seen by the greatest number of workers without causing traffic jams. Some plants provide a main bulletin board and departmental bulletin boards with postings applicable to a particular department. The material on the boards must be kept current: all material should be changed at least every three weeks and preferably it should be changed more often. The arrangement of the various messages should not be crowded lest a worker leave the scene without a single message. Some plants prefer to clear the board when an important message is to be posted. The use of color is a good attention getting device. Copy that is dramatic and attention catching is to be desired. The best method of getting attention is to put pictures of plant accidents on the board. People are interested in items when they are familiar with the people and the places.

It is desirable to have a bulletin board editor whose responsibility it is to keep the material current and interesting. Another important consideration is the attractiveness of the bulletin board. It is best that it be well kept

1. E. F. King, "Program of Safety Activities," Massachusetts Safety Council, Industrial Accident Prevention Course, Boston, 1941, p. 157.

as far as its physical condition is concerned. A glass case type of bulletin board is best in this respect as the various bulletins are kept clean and orderly. Some plants have a large outside bulletin board to communicate with their employees. (1) Mechanical devices to show certain safety statistics or records of safety improvement or progress are popular. (2) For example, a large device simulating an alcoholic thermometer indicating the number of man hours worked without a lost time injury or some other accident statistic may be used. Large outside bulletin boards are valuable for getting across safety ideas. Perhaps for each month the safety department might want to get a certain safety slogan across. "Breaking Rules May Cause Broken Bones." (3)

Bulletin boards are good for stimulating departmental rivalry for safety contests by posting the records of each. Bulletin Boards are used to give information about safety, to announce safety awards, to give news of safety committees and to let the working force of a department of the whole plant know just how good its performance is.

3. Plant Newspapers.

Safety advertising can be incorporated within the plant newspaper, provided that the paper is well written and

1. Ibid. p. 157.
2. Roland P. Blake, "Methods of Promoting Safe Practice," Industrial Safety, Roland P. Blake, Editor, Prentice-Hall, Inc., New York, 1946, p. 244.
3. Ibid. p. 245.

interesting enough to get good reader response. It is best that top management be behind the plant newspaper in order to give it authority and valadity. (1)

The editor and the safety head should work very close together in order to secure efficient and coordinated safety "news". The messages should be well written, practical and pertinent to plant conditions. (2) "Letters to The Safety Editor" column featuring safety suggestions from plant employees and with the follow-up by management printed under the suggestion is good.

4. Messages in Pay Envelopes.

Messages in the pay envelopes of workers are good as auxiliary devices to other means of creating and maintaining interest in safety. Moderation and the spirit of helpfulness instead of a spirit of dictating are important for effectiveness of this media as well as any other. (3)

5. Displays of Interesting Objects.

Another very effective way of advertising for safety is through the display of interesting objects. Perhaps a shattered pair of goggles might be displayed with a short clear story of the accident and the serious injury to the worker that the goggles prevented. Dangerous tools and implements that were detected by safety inspection before they could do

1. Ibid. p. 245.
2. Ibid. p. 244.
3. Ibid. p. 245.

damage make good displays, also. (1)

6. Signs and Slogans.

Signs and slogans, if correctly used, are efficacious for safety promotion. They should be truthful, clear, definite as to meaning and in good English. Signs should be clearly visible and meaningful to anyone approaching a hazard. Slogans should be timely, current and express a worthwhile goal. The most important thing to remember about slogans is that in order to be effective, the management must practice what it preaches. Slogans are worthless and meaningless in a plant full of mechanical and environmental hazards. (2)

7. Films and Slides.

Films and slides can be used rather effectively to aid in the safety education of the working force. Excellent slides and both sound and silent films can be obtained from The National Safety Council, from various insurance companies, and from various film libraries for a nominal charge or gratis. The investment that must be made for a projector is comparatively small and worthwhile. Arrangements should be made if at all possible so that as many as possible of the personnel may see the film or slides. The films should be interesting and enjoyable so that attention of the audience will be kept and that an impression will be made. Some plants that are

1. Ibid. p. 246.
2. Ibid. p. 246.

located in small communities arrange the safety film shorts to be shown in the local community theatre where most of the working force sees it. Other companies use it in the induction process. Another good way of getting the film shown to a great number of people is to show it to the various safety committees both employee and managerial. (1)

8. Manuals and Publications.

Finally, there are various manuals and publications that may be employed to bring the safety message to the worker. There are prepared manuals and booklets made up by the National Safety Council, by insurance companies and by various professional services. Some general magazinesrun editorials on industrial safety from time to time, reprints of which can be secured for general distribution to the workers. The individual company can make up its own safety pamphlet. W. H. Taylor of the Merrimack Manufacturing Company of Huntsville, Alabama, suggests the following in connection with plant produced safety manuals: (2)

1. Have a neat attractive binding.
2. Begin with a general set of safety rules that apply to all departments.
3. Make up a separate set of rules for each department pointing out the specific hazards and rules for that department.
4. Be brief and to the point. Use large easily read type.

1. W. H. Taylor, "Visual Education," Transactions of 31st National Safety Congress, National Safety Council, Chicago, 1942, p. 692.

2. Ibid. p. 692.

Lever Brothers has an attractive safety rule book that it distributes to each new employee. It was designed so that it would be read and understood. It is well written and amply illustrated. The booklet contains thirty-nine pages with a general introduction, general work rules and work rules that apply to specific work departments. At the end is an employees acknowledgment. The worker signs the following statement, "I have read the Safety Rules of Lever Brothers Company and agree to abide by them for my own safety and the safety of my fellow workers." The foreman signs the other side of the acknowledgment and states whether or no the employee knows his safety rules. (1)

F. Employee Participation

1. Means of Obtaining Employee Participation.

It is thought that employee participation in safety movements is perhaps the best way of instilling safety mindedness in the worker. This participation is accomplished in a number of ways. Safety contests and campaigns, safety meetings, safety suggestion systems and safety committees are some of the ways of encouraging participation in safety by employees. (2)

1. Lever Brothers Co., "Safety Organization," Revised Edition, Cambridge, Massachusetts.

2. Roland P. Blake, "Methods of Promoting Safe Practice," Industrial Safety, Roland P. Blake, Editor, Prentice-Hall, Inc., New York, 1946, p. 247.

2. Safety Campaigns.

Safety campaigns are good when there has been a let down in the safety mindedness of the organization personnel. Campaigns should be properly timed and properly run. In order to avoid the error of "rehashing" the same old material over and over again, care must be taken so that there is an element of newness in the campaign. There should be new faces, new roles, new presentations, new responsibilities and a freshening and intensification of effort. Good planning and leadership are fundamental. There should be a definite plan and it should be followed. A definite goal should be set up and the period that the campaign is to run specified. Much the same is applicable to contests. In contests however it is important that there should be clear and equitable rules of the contest in order that everything be fair and above board. (1)

3. Safety Meetings.

Safety meetings are good also in the promotion of safety. They are routine practice in the better run establishments. Some organizations have regular meetings with staff and supervisory personnel leaving the foremen to call their men together for safety meetings as the need appears. Almost any system works well if it has the essential element of executive supervision and interest. (2)

4. Safety Suggestions.

1. Ibid. p. 247.

2. Ibid. pp. 247-8.

The value of a safety suggestion system has been a matter of debate for quite some time among experienced men in the field of personnel management. Some safety people have had good experience; with others, the results have been disheartening. Nevertheless, properly administered, the suggestion system can effectively tap the great reservoir of resourcefulness and brain power and bring out many worthwhile suggestions on industrial safety. Roland P. Blake of the United States Department of Labor, Division of Labor Standards, suggests the following essentials for a good suggestion system:

1. The management must really want suggestions from its workmen.
2. Every suggestion must be taken seriously and, if it is not usable, an explanation must be made to its author as to why it was not.
3. Action in each instance should be prompt or the reason for unnecessary delay explained.
4. Anonymity should be respected if desired by the maker of the suggestion.
5. Rewards should be reasonable - relation to the value of the suggestion.
6. If the plant is organized, the cooperation of the union should be sought. (1)

5. Employee Committees.

Employee safety committees are invaluable in the furtherance of safe conditions and practices in the plant. The workman's committee is very valuable for it brings the viewpoint and the practical knowledge of the workman into the safety program; it is an invaluable aid in promoting worker interest in safety; and it's an aid in investigation

1. Ibid. p. 248.

of accidents. Management should have a sincere desire to enlist the help of the worker and to cooperate with the worker for the mutual development of safety. (1)

Lever Brothers Company booklet "Your Safety Committee" is a rather attractive and interesting manual on what employees' safety committees are and what they are supposed to do. The booklet states that the purpose of workers committees is to give the worker the opportunity of direct participation in the prevention of accidents. Representatives from each department in the plant are appointed to the committee. Regular meetings are held each month. Prior to a committee meeting, two members make a rather complete inspection tour of factory and report in writing the unsafe practices and conditions that were observed. The safety committee member is given a badge during his term of active service. On completion of active service a lapel button is substituted for the badge. (2) The book lists the exact duties that the member is assigned.

WHAT ARE YOUR DUTIES?

> Attend all committee meetings and take an active part in their proceedings.
> Abide by the rules and regulations in your Safety Rule Book. Read it again from cover to cover. If you have mislaid your copy, get another at the Safety Department.

1. T. O. Armstrong, "Safety Organization," Industrial Safety, Roland P. Blake, Editor, Prentice-Hall, Inc., New York, 1946, p. 272.

2. Lever Brothers Co., "Your Safety Committee," Cambridge, Massachusetts.

> Wear your safety badge at work so the folks in your department will know that you are on the committee.
> Interest your fellow workers in preventing accidents -- encourage them to report unsafe practices and conditions to their foreman or the Safety Department.
> Be observant when traveling through the plant and in your own department. Note all unsafe practices and conditions you observe. Report them to the foreman or the Safety Department.
> Set a good example -- take pride in your own safety record.

The booklet further explains what accident prevention is:

> Ninety-eight per cent of all accidents are the result of some one commiting a violation of a commonly accepted safe practice or permitting an unsafe practice to exist. These unsafe practices or acts and unsafe mechanical or physical conditions are the causes of accidents. To prevent accidents, we simply find and fix accident causes. Here are a few to be on the lookout for:
>
> (There follows four and one-half pages of general and specific unsafe practices and conditions. At the end of the booklet are six blank pages left for the suggestions of the committeemember.) (1)

G. Conclusions

Developing a high standard of safety mindedness in the working man is a very important phase of safety and accident prevention, for without it safe environments and managerial interest will not produce industrial safety.

1. Ibid.

IV. ACHIEVING SAFETY MINDEDNESS IN BUSINESS MANAGEMENT

A. Importance

It is also essential for our national industrial efficiency and for the conservation of our human resources that management be shown the importance of safety and be convinced of the importance of safety from the point of view of not only long range economic advantage but also from the viewpoint of short run personal benefit.

B. Techniques

Much the same techniques that are used to sell safety to the worker can be employed with management. The psychological traits that were outlined in the last chapter are universal; they exist in the human personality be it the personality of the worker or the personality of the executive. The approach must be modified slightly to fit the executives role and status in life, but the general principles are the same. Selling to top executives is differentiated from selling to production workers much the same as industrial salesmanship is differentiated from consumer salesmanship. Consumer sales like worker sales involve the emotional approach, chiefly, while industrial sales and sales to top executives involve the minimum of emotional appeals and the maximum of the cold, scientific, objective approach. Perhpas, therefore, it would be logical to break the sales approach to management into two classifications -- the humanitarian approach and the dollars

and cents approach.

C. Humanitarian Approach

In spite of a good deal of misconception to the contrary, it can be truthfully said that not all businessmen are after profits at the expense of the public and at the expense of labor. There are many business gentlemen that follow the moral dictates or religion in all their business dealings. This is the group to whom the humanitarian approach is most effective. These are the people who will not knowingly allow conditions to exist within their plants that are a potential danger to the life, happiness, health and security of their employees and their families. Long before our present workman's compensation laws were enacted by the various states, there were employers who consciously strove to make the workplace safe. In our modern complex society, the highly impersonal, very complex industrial system requires a supplement to the humanitarian approach to safety and requires a dollar and cents approach.

D. Dollars and Cents Approach

1. Measures of Safety Performance.

In the introduction, it was shown that the workman's compensation laws were the greatest factor in raising the level of industrial safety to where it is today. These laws made it directly expensive for any employer to have accidents in his plant. In the first chapter in the section on accident costs, the costs of accidents to the employer was shown and

the method of accident cost accounting was analyzed. If these costs are shown to the employer and the employer is made to see that accidents are a part of his unit costs of production, there would be developed a strong motive to cut these accident costs so that industrial efficiency might be achieved in this highly competitive society. Just as the intelligent and scientific management constantly endeavors to cut its various unit costs of production, it will also endeavor to cut down the production cost of a poor safety record when the true nature of the costs of accidents has been demonstrated to it.

Most insurance companies follow a scheme of making safety pay or the absence of safety cost money in figuring their premium rates for the workman's compensation policies that they write. The system works out something like this. The State sets up the minimum premium based on the number of dollars of payroll. The rate in Massachusetts is close to one dollar for every one hundred dollars of payroll. Insurance companies work on a "sixty percent basis." This means that if the costs of accidents over the preceding four years' period are more than sixty percent of the premium, the company is charged an additional premium. If the costs of accidents is less than sixty percent of the last four year's premiums, the insured is given a credit for maintaining a good safety record. This is a definite incentive for the adoption of safe practices and conditions within the plant. In addition, insurance companies usually follow the practice of making safety

inspections periodically and of aiding in evolving methods of achieving safe practices and safe conditions. Armed with posters, catalogues and indexes of safety devices and equipment, safety pamphlets, and technical know-how, the insurance companies give gratuitously aid and concrete practical advice on how the management of a particular firm may cut down on its insurance premium costs. (1)

Writing in the Transactions of The 30th National Safety Congress, W. H. Scates, Insurance Manager for Carnation Milk Company, gives this example in an article entitled "Selling Safety to Management". He states that many of the branch managers that he has talked to were surprised to learn that an insurance company is nothing more than a service agency which could lose no money on our insurance account, unless a major catastrophe occurred, but that operating costs could be sharply reduced by preventing accidents.

> "Remember now, that we are selling safety. Here is a manager whose plant accident cost was $100. This man's plant produces bottled milk and we will assume that the net profit on a quart of milk is 1¢. You can sell him on the close relationship between accident costs and net profit by stating that $100 is equivalent to the net profit on 10,000 quarts of milk. Such technique leaves an impression on the milkman. Or you could go further by stating that $100 is equivalent to the net profit of 10,000 quarts of milk, which, in turn, is equivalent to 18½ truckloads of bottled milk. To often, we permit these people to forget how closely related these expenses are to production expenses. We think of self insurance funds and insurance companies as godfathers to all accident

1. Interview with Liberty Mutual Insurance Company, Boston, Massachusetts.

costs". (1)

2. Means of Appraisal.

In order for a business executive to intelligently appraise the safety performance of his firm, he must apply certain measures that have been developed by safety engineers. It is not sufficient for an executive to know the number of accidents in his firm for a given unit of time, as he still won't know whether this record is good or bad. The measures that have been suggested by safety engineers are the frequency rate, the severity rate and the comparison of these rates with similarly circumstanced firms. These rates measure the experience of a given unit, they show the trend of accidents for a given period of time and they serve as a basis of comparison of the accident experiences of various units.

3. Frequency Rates.

The accident frequency rate is defined as the number of disabling injuries--an injury causing loss of working time beyond the day, shift or turn during which the injury was received--per 1,000,000 hours worked. For example what is the frequency rate for a firm with 80 workers averaging 40 hours a week each, if in 6 months, 4 workers were injured?

1. W. H. Cates, "Selling Safety to Management," Transactions of 30th National Safety Congress, National Safety Council, Chicago, 1941, p. 345.

$$\text{Accident Frequency rate} = \frac{\text{number of disabling injuries x 1,000,000}}{\text{total number of man hours worked}}$$

$$= \frac{\text{4 injuries x 1,000,000 man-hours}}{\text{80 workers x 40 hrs. a week x 26 weeks}}$$

= Answer 48.Plus (1)

4. Severity Rates.

The accident severity rate is defined as the number of days lost per 1,000 man-hours worked. It tells how serious the accidents are. What is the accident severity rate for the firm in the above example, if the workers lost jointly 103 days from work?

$$\text{Accident severity rate} \quad \frac{\text{number of days lost x 1,000}}{\text{total number of man-hours worked}}$$

$$\frac{\text{103 days lost x 1,000 man-hours}}{\text{80 workers x 40 hours per week x 26 weeks}}$$

Answer 1.2 (2)

5. Standards of Computation.

For the sake of uniformity, all rate calculations should be made in accordance with the provisions of the "American Standard" Method of computing accident rates. Also included within the American Standard is the scale of time charges that various injuries involve. 6,000 days is charged for death. This figure is derived from insurance company statistics which showed that during the period covered by the study that the average man killed in an industrial accident

1. W. Dean Keefer, "Appraising Safety Performance," Industrial Safety, Roland P. Blake, Editor, Prentice-Hall, Inc., New York, 1946, p. 32.

2. Ibid. p. 33.

had a working life expectancy of about 20 years or 6,000 days. Permanent total disability is given the same lost-time weighting as is death and other permanent disabilities are charged with fractions of the 6,000 day total. (1)

6. Which Rate if The Better.

There is difference of opinion as to which rate is the better to use. The writer has been to one plant where severity has been considered the more important, to another where frequency has been the more important, to still another where their own modifications of the standard measures have been made.

7. Arguments for Severity Rate.

The ones who believe that severity rates are the more important indicators say that from a humanitarian and financial view that a reduction in deaths and other serious injuries as indicated by the shrinking severity rate is more important than is a reduction of the less serious accidents that necessitate only a few days lost time each. Looking at it another way, a plant that has a decreasing frequency rate with an increasing severity rate would show a definite need for more intensive engineering work to eliminate especially hazardous conditions that might otherwise not be attended to. (2)

1. Ibid. p. 32.

2. Ibid. p. 33.

8. Arguments for Frequency Rates.

There are arguments on the other side of the question, however. In the first place all accidents are a potential cause of death or very serious injury, although it may result in a very minor injury or no injury at all. Therefore, attention should be given to the elimination of all accidents not just the very serious ones. Furthermore luck is a very big factor in all accidents. For example, in an automobile assembly plant, a part may fall from an overhead conveyor that was unguarded for one reason or another and kill a worker or it may only fall to the floor with no injury to a human being. In the first case, a 6,000 lost day charge was added to the severity rate and one injury to the frequency rate. In the second case no change in either the frequency or severity rate occurred. When comparing two plants, obviously the frequency rate eliminates the luck factor faster than does the severity rate. From an accident prevention point of view, both accidents are of equal importance, however. In contests between two units, the frequency rate is the preferable to the severity because of the luck factor. One death or serious injury would cause the competitors to give up the contest. Many people feel that in a contest some penalty should be inflicted on the basis of severity but only as an adjusted factor. (1)

9. Presentation of Rates.

The presentation of these rates should be made in

1. Ibid. pp. 33-4.

such a way that the top executives can understand them without too much specialized knowledge of safety statistics. All the various means of visual presentation should be used to supplement the purely statistical data. Bar charts, pictorial graphs, pie charts and other facilitating techniques should be employed. (1)

10. Source of Comparison Standards.

The Bureau of Labor Statistics of the United States Department of Labor and The National Safety Council publish the frequency and severity rates for various industries so that the individual executive can easily see how his firm rates in comparison with the average in his type of industry.

E. Conclusion

Management can be approached on the financial and the humanitarian basis to improve its accident performance. The problem is to show management how much accidents cost by means of accident cost accounting systems such as developed by H. W. Heinrich and shown in the introductory chapter, and to give to management an objective measure by which it can appraise its performance. The humanitarian approach may be effective also in conjunction with the financial approach; few responsible people desire to cause pain and suffering.

1. Ibid. p. 35.

V. MECHANICAL ASPECTS OF SAFETY

A. Importance

Industrial safety may be likened to a triangle; one side is the psychological-environmental phase, the second is the educational phase, and the third is the mechanical phase of safety. Machine guarding and related fields are principally the affairs of the safety engineer whose task it is to design and utilize various mechanical devices to protect the worker's life and limb from whirling machinery. Nevertheless, it is important that the personnel manager have at least a little knowledge of the fundamentals of theory and practice of mechanical aspects of safety. It is with this purpose in mind that the mechanical phase of safety is briefly discussed. It is not to be assumed that machine guarding is not an important consideration in safety by the brevity of the treatment; rather it is because mechanical aspects of safety are beyond the scope of this paper that the treatment is brief.

B. Accident Causes

Very often, accidents are charged to the wrong cause. Accidents that happen from circumstances that could be guarded against by improved physical conditions and protective apparel are often attributed to "personal carelessness" which is frequently only a contributory factor and most difficult to control. Reference to all types of compensated industrial injuries shows that mechanical apparutus charged is with a relatively

small percentage of the total. Table #1, page 77, showing New York's experience will illustrate this point. It will be seen from this chart that while only 13% of total injuries were charged to mechanical apparatus, in manufacturing alone the figure was more than 28%. (1) This is on the basis of frequency alone and table #2, page 78, shows where the more serious accidents occur. Here it will be noticed that the chance for serious injury is highest when an individual gets caught in an elevator or in a conveyor, or in machinery. From these two tables there is a strong suggestion that in manufacturing industries, accidents resulting from machinery occupy a very important position. (2)

Accident factors can be divided on the basis of those resulting from unsafe acts of persons and those resulting from unsafe mechanical and physical conditions. The relative importance of each has long been a matter of controversy. The classical view is that 70 to 85% of all accidents are due to "faulty acts of persons while mechanical causes account for only 15 to 30%. Studies made in 1939 by the National Safety Council throw a little different light on the problem. In this survey 1000 industrial accidents were carefully investigated and impartially analyzed. The results seem to indicate that 20% of the accidents were due to the careless acts of persons, 20% due

1. E. R. Grannis, "Mechanical and Personal Safeguarding of Workers," Industrial Accident Prevention Course, Massachusetts Safety Council, Boston, 1941, p. 98.

2. Ibid. p. 98.

TABLE 41

MECHANICAL APPARATUS INJURIES BY INDUSTRY (1)
NEW YORK STATE (5 Years)

Industry	Injuries Compensated No.	% of total for state	Charged to Mechanical Apparatus No.	% of total for industry
Manufacturing	66823	32.4	18924	28.3
Construction	47798	23.2	4088	8.8
Transportation & Public Utilities	32106	15.6	1029	3.2
Service - Mercantile	31325	15.2	2261	7.2
Trade	23375	11.4	1485	6.4
Other Industries	4309	2.1	411	9.4
Total	205736		21898	13.7

1. E. R. Grannis, "Mechanical and Personal Safeguarding of Workers," Industrial Accident Prevention Course, Mass. Safety Council, Boston, 1941, p. 98.

TABLE # 2

SEVERITY OF INJURIES BY SOURCE OF OCCURRENCE (1)

Injury Source	Total Cases	Fatal and Permanent Total	Permanent Partial Disabilities	% of total Resulting in Severe Injury
Handling Objects	60179	188	10212	17.3
Using Hand Tools	15104	42	3437	23.0
Falls to a Different Level	19880	524	4206	23.8
Falls to Same Level	21206	121	3315	16.2
Machinery, Prime Movers, etc.	22773	109	8539	38.9
Elevators, Hoists, Conveyors	5423	252	2006	41.6
Vehicles	18751	665	4505	27.6
Falling Objects	12517	228	2893	24.9
Electricity, explosives, Heat	7908	283	876	14.6
Harmful Substances	3359	57	226	8.4
Stepping or Striking Against	9679	32	888	9.5
Other and Indefinite	8958	122	1650	19.8
Total	205736	2623	42752	22.1

1. E. R. Grannis, "Mechanical and Personal Safeguarding of Workers," Industrial Accident Prevention Course, Mass. Safety Council, Boston, 1941, p. 99.

to faulty physical conditions, and the remaining 60% were due to a combination of the two factors; the elimination of either alone would make for an 80% reduction in accidents. The survey pointed to a more strict attention to physical causes in the future. (1)

C. Approach

1. Cooperation between Safety Dept. and Purchasing Agent.

In providing safe surroundings two approaches are necessary. New equipment, as acquired, must be of the proper make and type and maintenance of the existing plant and equipment must be adequate. The safety director and the purchasing agent should work rather closely especially where the aquisition of protective equipment is involved. Edward R. Granniss, Director Industrial Division of the National Conservation Bureau suggests the following ways of obtaining cooperation between the purchasing agent and the safety department:

1. Provide for the purchasing agent information on types of accidents, on accident causes, etc., where the accidents have resulted from or been made more serious because of the failure of some mechanical equipment.

2. Provide specific information about machines and process hazards which could have been eliminated by a different design or by something that the manufacturer might have provided.

3. Give similar information about health, occupational and fire hazards which may be involved.

1. Ibid. p. 99.

4. Provide information as to safety requirements.

5. Give assistance of the purchasing agent in the investigation of accidents which may have been caused by faulty equipment.

6. Invite the purchasing agent to attend general safety meeting of employees. (1)

Granniss gives a good example from an actual situation showing how lack of cooperation between the safety department and the purchasing department or at least how the failure of the purchasing department to spend a few extra dollars to properly protect a machine actually cost the company more money than would have been necessary had there been proper guarding.

Cost of a circular saw without a guard	38.50
Cost of an injury in which the finger of a worker was amputated	78.50
Total cost of unguarded saw including accident	117.00
Original cost of saw if properly guarded	60.50
Savings possible in original purchase of guarded saw	56.50 (2)

D. Machine Guarding

1. Power Transmission Guarding.

Machine guarding can logically be divided up into two separate parts. The first phase is power transmission guarding. Mechanical power transmission is usually so defined as to

1. Ibid. p. 101.

2. Ibid. p. 101.

include all moving parts used in the transmission of power, including prime mover, intermediate equipment and driven machines excluding the point of operation. Transmission apparatus includes gears, pulleys, belts, shafting, starting and stopping devices, couplings, clutches, prime movers and other equipment used in transmitting power. The safety code approved by the American Standards Association, "Mechanical Power Transmission" has received national acceptance and is followed by most states. This code effectively covers the general details of such guards. (1) It is undoubtedly the best code on the subject. (2) It should be used as a detailed reference on what equipment should be used and how guards should be made. Mr. Granniss lists a few of the more pertinent and important principles to be extracted from the code as a guide to power transmission guarding.

a. Guards should be substantial and firmly secured in place.

b. The most satisfactory material, generally, is metal. Perforated or expanded metal, or reinforced screening mounted on angle irons or pipes are preferred materials. Wooden guards frequently lack strength, become rickety, require frequent replacement and may contribute to a fire hazard. In special cases, the presence of corrosive fumes may seem to make wooden guards advantageous. However, if fumes are strong enough to attack metal guards, they will also have a bad effect on the workers and

1. Ibid. p. 101.

2. S. W. Homan, "Guarding of Transmission Machinery," Industrial Safety, Roland P. Blake, Editor, Prentice-Hall, Inc., New York, 1946, p. 185.

it is suggested that the fumes be removed rather than wooden guards recommended. The first cost of wooden guards is usually low, but maintenance costs usually make them as expensive if not more so than other construction.

c. All machine controls should be conveniently located and guards should not interfere with cleaning, oiling, or adjusting. A transmission guard, in fact, should provide protection for oilers and adjusters, and it should not be necessary to remove such guards that these operations may be performed.

d. Guards should not have sharp corners nor constitute tripping hazards nor be so placed that workers may strike against them.

e. Guards for belts, overhead gears, overhead conveyors, etc. should be strong enough to hold any parts that may break and fall into them. (1)

Like any other codes the standards are the minimum standards and must be adjusted to suit heavier requirements that might arise in a particular situation in a particular plant. (2)

2. Point of Operation Guarding.

The second phase of machine guarding is termed point of operation guarding. The New York State Code defines point of operation guarding:

Machines having a grinding, shearing,

1. E. R. Grannis, "Mechanical and Personal Safeguarding of Workers," Industrial Accident Prevention Course, Massachusetts, Safety Council, Boston, 1941, p. 102.

2. S. W. Homan, "Guarding of Transmission Machinery," Industrial Safety, Roland P. Blake, Editor, Prentice-Hall, Inc., New York, 1946, p. 186.

> punching, squeezing, drawing or cutting action, in which the operator's hands come within the danger zone, shall be guarded to the point of operation where the operator may be caught between the moving parts of the machine, between moving and stationary parts, or between the material and a part or parts of the machine. (1)

Just how important is point of operation guarding? The guards are expensive and protect only one person at a time. (2) The following charts - #3, page 84 and #4, page 85 - of New York experience for five years show the frequency and severity of point of operation accidents. Chart #3 shows the percentage of accidents happening on various point of operation machines. The most dangerous are the power presses, circular saws, jointers and metal shears. Chart #4 on wood working accidents shows the dollar and cents side of the picture (severity), shapers and circular saws being about even for the most costly per accident. (3)

3. General Comments.

A few general comments are in order before delving into the theory and practice of point of operation guarding. In the first place, machines should be guarded to the point where they will protect the least careful and not merely cover the minimum requirements of the law or protect the most careful

1. E. R. Grannis, "Mechanical and Personal Safeguarding of Workers," Industrial Accident Prevention Course, Massachusetts, Safety Council, Boston, 1941, p. 102.
2. Ibid. p. 102.
3. Ibid. p. 103.

TABLE # 3

COMPENSATED MACHINES INJURIES-NEW YORK STATE (5 YEARS) (1)

	Number of Injuries	Fatal & Perm.total	Permanent Partial disability	
			Number	Per Cent
Sewing machines	5027	1	411	8
Power Presses	4811	6	2694	56
Circular saws(woodworking)	4399	34	2251	52
Cloth cutting and stamping machines	2704		330	12
Food cutting and chopping machines	2284	2	862	38
Portable power tools	2135	5	771	36
Abrasive wheels	1968	30	718	36
Printing presses	1745	3	665	38
Jointers and planers	1432	4	736	51
Ironing machines	1140	2	371	32
Lathes and automatic screw machines	1094	1	450	41
Hand and foot presses	974		215	22
Metal shears	936	2	411	44
Wood shapers	608	1	366	60
Total	31197	91	11254	Average 36

1. E. R. Grannis, "Mechanical and Personal Safeguarding of Workers," Industrial Accident Prevention Course, Mass. Safety Council, Boston, 1941, p. 102.

TABLE # 4

WOODWORKING MACHINE INJURIES-NEW YORK STATE (5 YEARS) (1)

	No. of Injuries	Fatal and Perm. Total	Compen-sation	Dollars of Compensation per Injury
Saws (circular)	2796	19	$1573378	$563
Surfacing and edging machine	1086	4	452420	417
Shapers	385	-	217465	564
Saws (Band, scroll, jig)	173	1	70410	407
Lathes, sanders, borers, drills, motisers, nailers, pressers	475	3	131752	277
Machines (not point of operation)	320	1	107736	336
Total	5235	28	$2553161	$488

1. Ibid. p. 103

worker. The law of averages tends to work against this idea. (1) Eventually, every uncontrolled hazard will produce an accident. Even the most careful operator is bound to make a mistake sometime in his work career. Furthermore, a great many machine operators are not adequately selected, trained and supervised and hence need the protection of complete guarding. To prevent tampering or the removal and failure to replace by operators, guards should be made an integral part of the machine. Mr. Granniss suggests the following check items to be used in ordering a machine to insure having safety features built in.

1. Enclose all dangerous moving parts.
2. Make conveniently and safely accessible those parts which are subject to wear or which need adjustment and lubrication by hand.
3. Provide automatic lubrication whenever possible.
4. Provide mechanical devices to bring materials to machines and to take them away.
5. Automatically remove dust, gasses, fumes and other harmful materials from the working zone.
6. Eliminate noise as far as possible.
7. Eliminate vibration as far as possible.
8. Eliminate such motions of machine parts as may cause eye strain (for example, moving parts that must be viewed through screen or lattice work).
9. Make provision for mounting accessories, such as guards, through bosses cast on the frame work and in other possible ways. Use adequate factors of safety.
10. Design the outside shape of the machine so that danger from tripping, falling and

1. Ibid. p. 104.

contact will be minimized. (rounded corners lessen the danger of injury by collision.) (1)

4. Theory and Practice of Point of Operation Guarding.

The actual theory and practice of point of operation guarding embraces eight phases:

1. Designing and constructing machines so that supplementary guards are unnecessary.
   a. Perhaps one of the best examples of this is the pencil sharpener, whose cutting edges are placed under a cover.

2. The use of guards, barricades, enclosures and covers.
   a. One of the most effective, least expensive and simplest point of operation guards.
   b. Adaptable to a wide variety of uses.
   c. Good example is the circular saw cover.

3. Mechanical feed devices.
   a. Makes it unnecessary for the worker to place his hands in the danger zone.
   b. Best used in conjunction with other safety devices.
   c. Good example is meat or bread slicing machine which employ a screw slide feed.

4. Interrupting devices.
   a. The device prevents or interrupts the movement of machinery while the operators' hand or hands are in the danger zone.
   b. A good example is the job printing press platen guard.

5. Remote control mechanisms.
   a. Push buttons, levers, switches, handles and other tripping devices are placed at a safe distance from the danger points and require the use of both hands.

1. Ibid. p. 104.

6. Devices that remove hands from the danger zone.
   a. A mechanical force is employed in such a way that hands are pulled from the danger zone whether they are there by intention or otherwise.

7. Combination of devices.
   a. The most effective point of operation guarding is achieved by combinations of the devices used above.

8. Accessories and incidental devices.
   a. Non-repeat devices that stop the machine from making a second cycle.
   b. Hand tools that make it unnecessary for the operator to place his hands in the danger area. (1)

E. Conclusion

There is much to accident prevention other than machine guarding; nevertheless, when on inspection and analysis unsafe mechanical environment is found to exist, the first point of attack should be attention to machine guarding, both point of operation and transmission. It is conceivable that certain forms of correction might be too expensive to undertake in the short run; in the long run, however, they must be undertaken as compensatory means such as employee education and selection are only temporary short run expedients to safety. (2)

1. H. W. Heinrich, "Industrial Accident Prevention," McGraw Hill Book Co., Inc., New York, 1941, pp. 170-217.

2. E. P. Grannis, "Mechanical and Personal Safeguarding of Workers," Industrial Accident Prevention Course, Massachusetts, Safety Council, Boston, 1941, p. 104.

VI. SUMMARY AND CONCLUSION

A. Cost of Accidents

It was shown at the beginning of this paper that industrial accidents exact huge tolls in wealth, income and resources from our industrial society, from our economic society and from society as a whole. The greater cost of utility is society's penalty for allowing industrial accidents to lower the efficiency of its productive machine. The entrepreneurs or owners of businesses are fined for lack of accident prevention through increased costs of production. The worker has to pay the largest (and most regressive tax) levied by industrial accidents. The laborer or craftsman loses his income, suffers increased living expenses and undergoes mental anguish and physical pain as his penalty. The current thought of industrial psychologists, industrial engineers, safety engineers, industrial management practitioners and other students in the field of industrial safety is that much of the price that is paid is unnecessary and through the intelligent use of the modern scientific principles laid down and being constantly developed by scientists in the fields of engineering, administration, education and psychology and psychiatry, society can reduce to an irreducible minimum the frequency, severity and resultant costs of accidents. This is the viewpoint from which this paper is written. Roland P. Blake, Senior Safety Engineer, Division of Labor Standards, United States Department

of Labor in his preface to "Industrial Safety" has summed up this thought rather well.

> The outstanding lesson to be drawn from a study of the progress of safety accomplishment is undoubtedly that the present accident waste is almost wholly needless. This waste - a serious continuing drain on our national resources of human and material values - can largely be eliminated if only we can bring about the application of informed, safety-minded, common sense to the day-by-day work in the multitude of establishments that constitute American Industry." (1)

B. Safety Triangle

1. Psychological Aspects.

The concept of the safety triangle has been adopted in this writing. One of the sides of the triangle is the phase of accidents that are related to the interaction of environment, heredity and personality. Certain environmental conditions are within the province of the industrial engineer or of the safety engineer. The problem of the human personality and the human mind and its interaction with the environment are within the province of the psychologist and the psychiatrist. There is great promise here. Their continually developing body of knowledge and techniques of delving into the human mind and correcting its malfunctions is and will become an increasingly more effective route to the elimination of accident proneness.

2. Educational Aspects.

1. Roland P. Blake, "Industrial Safety," Preface, Roland P. Blake, Editor, Prentice-Hall, Inc., New York, 1946.

Another side of the safety triangle is the educational side. Although subconscious motivation is by far the most important factor in human behavior in the opinion of the majority of psychoanalysts, there is room in the field of industrial safety for tools of conscious motivation. Various advertising, propaganda and educational techniques are most efficacious in obtaining in a worker interest, appreciation and desire for safety. Many of the same technique work well with management also. Here, of course, the emphasis is on the "dollar and cents" aspect of safety and accidents. Systems of accident cost accounting such as those developed by H. W. Heinrich are most helpful and useful in impressing on management the importance of safety in their own language.

3. Mechanical Aspects.

The final side of the safety triangle is the mechanical side. In order for the other two sides of the safety triangle to be effective, the machinery must be safe. The safety engineer must constantly strive to perfect machinery and machine guarding so that the worker's life and limb will be protected from high speed, powerful machinery. This is the most controllable variable in safety - machines can be made almost foolproof whereas the other two sides of the picture are not so readily controlled. Therefore, the plant should be made free from hazards before the educational or psychological work begins.

BIBLIOGRAPHY

1) Alt, Harold A., "Practical Air Conditioning," Domestic Engineering Co., Chicago, 1936.

2) The American Academy of Political and Social Science, "Industrial Safety," The Annals, Philadelphia, 1926,
Green, William, "The Need for Safety From the Worker's Point of View."

Alexander, M. W., "The Need of Safety from The Employer's Point of View."

3) Blake, Roland P., Editor, "Industrial Safety," Prentice-Hall, Inc., New York, 1946,
Keefer, W. Dean, "Introduction to Safety Engineering."
Keefer, W. Dean, "Accident Costs."
Keefer, W. Dean, "Brief History of Industrial Safety in America."
Blake, Roland P., "Methods of Promoting Safe Practice."
Keefer, W. Dean, "Appraising Safety Performance."
Armstrong, T. O., "Safety Organization."
Homan, S.W., "Guarding of Transmission Machinery."

4) Heinrich, H. W., "Industrial Accident Prevention," McGraw Hill Book Co., Inc., New York, 1941.

5) Lever Brothers Co., "Safety Organization," Cambridge.

6) Lever Brothers Co., "Your Safety Committee," Cambridge.

7) Massachusetts Safety Council, "Industrial Accident Prevention Course," Boston, 1941,
Grannis, E. P., "Mechanical and Personal Safeguarding of Workers."
King, E. F., "Program of Safety Activities."

8) Moore, Herbert, "Psychology for Business and Industry," McGraw Hill Book Co., Inc., New York, 1942.

9) Morrow, Robert L., "Time Study and Motion Economy," Ronald Press, New York, 1945.

10) National Safety Council, "Transactions," 30st Safety Council, Chicago, 1941,
Cates, W. H., "Selling Safety to Management."

11) National Safety Council, "Transactions," 31st Safety Council, Chicago, 1942,
Taylor, W. H., "Visual Education."

12) Pigors, Paul and Myers, Charles A., "Personnel Administration," McGraw Hill Book Co., Inc., New York, 1947.

13) Smith, May, "Handbook of Industrial Psychology," Philosophical Library, New York, 1944.

14) Viteles, Morris S., "Industrial Psychology," W. W. Norton and Co., New York, 1932.

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